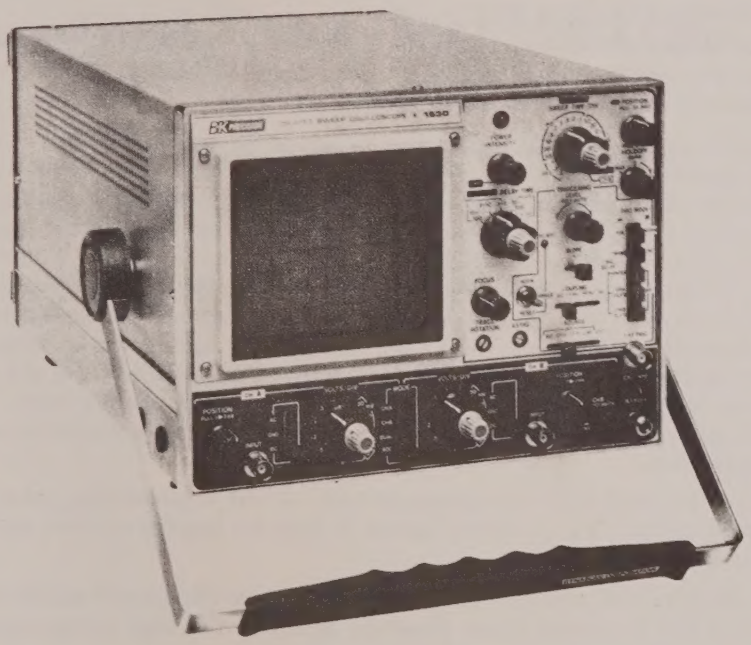
INSTRUCTION MANUAL

B+K PRECISION 1530

30 MHz, DELAYED SWEEP

Dual-Trace Oscilloscope



B+K PRECISION DYNASCAN CORPORATION

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Higher voltages pose an even greater threat because such voltage can more easily produce a lethal current. However, voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.
2. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet. Where insulated floor surface is not available, wear heavy gloves.
3. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
4. Always use an isolation transformer to power transformerless "hot chassis" equipment, where one side of the ac power line is connected directly to the chassis. This includes most recent television sets and audio equipment. Without an isolation transformer, the chassis of such equipment may be floating at line voltage (120 VAC, 60 Hz in USA), depending upon which way the 2-wire ac power plug is inserted. Not only does this present a dangerous shock hazard if the chassis is touched, but damage to test instruments or the equipment under test may result from connecting the ground lead of some test instruments to a "hot" chassis. The ground lead of most oscilloscopes and most other test instruments with 3-wire power plugs is at earth ground. The B & K-PRECISION Model TR-110 Isolation Transformer is suitable for most applications.
5. On test instruments or any equipment with a 3-wire ac power plug, use only a 3-wire outlet. This is a safety feature to keep the housing or other exposed elements at earth ground.
6. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
7. Also remember that ac line voltage is present on some power input current points such as on-off switches, fuses, power transformers, etc., even when the equipment is turned off.
8. Never work alone. Someone should be nearby to render aid if necessary. Training on CPR (cardo-pulmonary resuscitation) first aid is highly recommended.

Instruction Manual
for

B+K PRECISION

Model 1530

30 MHz, Delayed Sweep

Dual-Trace Oscilloscope

B+K PRECISION DYNASCAN CORPORATION

6460 West Cortland Street
Chicago, Illinois 60635

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INTRODUCTION

The **B & K-Precision** Model 1530 Dual-Trace Oscilloscope is an accurate, professional instrument with its primary applications in engineering design labs, factory test and analysis centers, and well-equipped service shops or field service facilities. The delayed sweep feature of this oscilloscope permits close examination of a waveform; the variable delay permits any portion of the waveform to be examined. All waveforms up to 30 MHz can be expanded at least 5 times, and waveforms with repetition rates up to about 25 kHz can be expanded up to 1000 times. Such waveform displays are very useful, for example, for detecting high speed pulse aberrations, finding "glitches" in digital circuits, measuring rise time and decay time, and convenient in video systems for viewing any specific line or vertical field information such as VITS and VIR in the vertical blanking interval. The CRT has plenty of brightness to easily view waveforms at sweep expansion of 1000 times, where the sweep duty cycle drops to 0.1%. This oscilloscope permits you to display the channel A or channel B signal on the delayed sweep, as desired. For fast set-up an adjustment of delay time, the delayed portion of the trace may be intensified.

Performance features of the Model 1530 include high accuracy of both amplitude and time measurements (±3%), high sensitivity (5 mV/division), wide bandwidth (30 MHz), and fast rise time (11.7 ns). Most measurements can be made on an extra sensitive range of 2 mV/division. Even at 2 mV sensitivity, bandwidth is 20 MHz and rise time is 17.5 ns. Accuracy is enhanced by a rectangular CRT with internal graticule and post-deflection acceleration.

Naturally, the Model 1530 includes all the operational features you expect of a high quality, laboratory oscilloscope. Dual-trace operations permits two waveforms to be viewed simultaneously, or each may be viewed independently. An ADD mode allows both inputs to be summed and displayed as a single trace, or the channel B signal may be inverted for "subtract" operation, which is very useful for differential and distortion measurements. The chop or alternate method of dual-trace generation is selectable at sweep times of 1 ms/division and slower; alternate sweep is automatically selected at all faster sweep speeds. The matched, dual vertical amplifiers can be switched to provide vetical and horizontal deflection in X-Y operation, at the same calibrated sensitivities. A sensitive (2-volt, TTL compatible) Z-axis input permits intensity modulation from an external signal for time or frequency markers.

A wide selection of triggering modes permits a synchronized, jitter-free display of almost any waveform. With internal triggering, any signal that produces at least 1 division of vertical deflection is adequate for sweep triggering. A variable trigger threshold level and choice of negative or positive slope permits triggering at any desired point on a waveform. A selectable FIX mode bypasses the level control and automatically fixes the triggering level at the center of the trigger waveform, a real convenience when making a series of measurements at various amplitudes and dc levels. In internal triggered dual-trace operation, the channel A or channel B signal may be selected as the trigger source, or alternate triggering may be selected. With alternate triggering, two signals that are not related in frequency or time may be viewed simultaneously. Of course, external and 50/60 Hz power line triggering are also selectable, and an AUTO mode generates a sweep without an input trigger. Selectable trigger coupling includes low-frequency reject and high-frequency reject filters to attenuate interfering components for less jitter. A single sweep mode permits presentation of a non-periodic event such as a relay closure. Variable hold-off allows triggering to be inhibited beyond the normal duration after sweep completion; some complex pulse trains require variable hold-off to obtain a calibrated, synchronized display. For viewing video waveforms, a selectable built-in sync separator permits triggering from vertical or horizontal sync pulses.

Convenience features include electrical trace rotation that is adjustable from the front panel, a built-in square wave generator for probe compensation adjustment, a sturdy carrying handle that also serves as a tilt stand with a choice of several angles of tilt, and a slotted bezel for mounting a standard oscilloscope camera for making waveform photographs. The conveniently grouped and well identified controls contribute to ease of operation, and the styling is clean, modern, and attractive. Solid state, integrated construction contributes to reliability and dependability, as well as the low power consumption of 28 watts.

FEATURES

DELAYED SWEEP Permits closer examination of any portion of a waveform. Sweep trigger may be delayed from 1 microsecond to 100 milliseconds, independent of sweep rate. Permits waveform expansion up to 1000 times.

ALTERNATE DELAYED SWEEP In alternate dual-trace operation, either the channel A or channel B trace may be delayed, while the alternate trace is non-delayed for reference.

INTENSIFIED DELAYED SWEEP Selectable intensity modulation brightens delayed portion of non-delayed trace for convenient identification of delayed sweep beginning point.

ACCURATE CRT Rectangular, domed CRT provides constant electron beam length. Internal 8 x 10 division graticule reduces parallax error. Mesh type acceleration provides fine trace for accurate measurements.

HIGH BRIGHTNESS 6 kV mesh-type acceleration and bright phosphors permit waveforms to be viewed at trace duty cycle of 0.1% or less (sweep expansion of 1000 times or more).

30 MHz BANDWIDTH – 3 dB bandwidth is conservatively rated at DC to 30 MHz at 5 mV/division sensitivity for distortion free high-resolution presentation at high frequencies. Even at 2 mV/division sensitivity, bandwidth is 20 MHz.

HIGH SENSITIVITY 2 mV/division sensitivity for measurements up to 20 MHz, 5 mV/division up to 30 MHz. Permits the low-capacitance, high-impedance 10:1 attenuation probes to be used for virtually all measurements, thus assuring minimum circuit loading.

USABLE TO 50 MHz Triggers on signals to 50 MHz. Smooth roll-off above 30 MHz, response is typically down – 6 dB at 49 MHz.

11.7 ns RISE TIME Short duration pulses not viewable on other lab scopes are clearly viewable when expanded on 5X magnification. Even at 2 mV/division sensitivity, rise time is 17.5 ns.

DUAL TRACE Two input waveforms can be viewed individually or simultaneously, as desired. Completely independent adjustment of the two signal amplitudes. Alternate or chop dual-trace generation method selectable at lower sweep rates, alternate automatically selected at faster sweep rates.

TRIGGERED SWEEP Selectable trigger source; alternate, channel A, channel B, line or external. Fully variable LEVEL control allows any desired point on waveform to be used for triggering, or to set an amplitude threshold which must be exceeded to obtain a sweep.

ALTERNATE TRIGGERING In alternate dual-trace operation, the channel A trace can be triggered by the channel A signal and the channel B trace by the channel B signal. Permits simultaneous viewing of two waveforms not related in frequency or period.

AUTOMATIC SWEEP Selectable AUTO sweep operation provides sweep without trigger input, automatically switches to triggered sweep operation when adequate trigger is applied.

AUTOMATIC TRIGGER LEVEL Selectable FIX mode automatically fixes triggering level at center of trigger signal, regardless of LEVEL control setting. Saves set-up time for most waveform viewing.

SINGLE SWEEP SINGLE mode enables a single sweep, which will begin at the next sweep trigger.

HOLDOFF Variable "holdoff" period after sweep, during which trigger for next sweep is inhibited. Permits synchronization of complex pulse train at calibrated sweep rates.

LF AND HF REJECT TRIGGER COUPLING Selectable filters attenuate low or high frequency component of trigger signal for less jitter.

VIDEO CAPABILITY Selectable FRAME-LINE circuit permits triggering from vertical sync pulses (FRAME) or horizontal sync pulses (LINE) for viewing composite video waveforms.

20 CALIBRATED SWEEP SPEEDS Accurate time measurements (±3%) on 20 different ranges. Sweep speed range of 0.2 μs/div to 0.5 s/div provides every sweep speed necessary for viewing waveforms from dc to 30 MHz.

5X MAGNIFICATION A five times (5X) magnification of the horizontal sweep allows closer examination of waveforms without setting up delayed sweep operation. In addition, 5X magnification provides a maximum sweep rate of 40 ns/div.

11 CALIBRATED VOLTAGE SCALES Accurate measurement (±3%) of instantaneous voltages on 11 different ranges for both channel A and channel B (2 mV/div to 5 V/div).

SUM AND DIFFERENCE CAPABILITY Permits algebraic addition or subtraction of channel A and channel B and display as a single trace. Useful for differential voltage and distortion measurements.

X-Y OPERATION Channel B input can be applied as horizontal deflection (X axis) while channel A input provides vertical deflection (Y axis). Horizontal axis sensitivity is 2 mV/div.

Z-AXIS INPUT Intensity modulation capability permits time or frequency marks to be added. Trace brightens with 2-volt or more positive signal, TTL compatible.

BUILT-IN PROBE COMPENSATION SQUARE WAVE A built-in 0.5 volt peak-to-peak, 1 kHz square wave generator permits probe compensation adjustment and a general check of calibration accuracy.

ELECTRICAL TRACE ROTATION Trace rotation is electrically adjustable from the front panel.

REGULATED POWER SUPPLY All voltages are regulated, including high voltage for the CRT, assuring that brightness, sensitivity, and accuracy are unaffected by line voltage variations.

MECHANICAL FEATURES Carrying handle with comfortable molded finger grip also doubles as tilt stand. Locking detent each 22½° allows adjustment of viewing angle. Rear feet support oscilloscope in face-up position and double as cord wrap for storing power cord. Slotted bezel over face of CRT mounts standard oscilloscope camera for making waveform photographs.

SPECIFICATIONS

VERTICAL AMPLIFIERS (CH A and CH B)

Deflection Factor	5 mV/div to 5 V/div, ±3%. 2 mV/div, ±3%.
Attenuator	10 steps, 5 mV/div to 5 V/div in 1-2-5 sequence, plus 2 mV/div gain change step. Vernier control for fully adjustable sensitivity between steps.
Frequency Response	
5 mV/div to 5 V/div	DC: DC to 30 MHz (−3 dB). AC: 5 Hz to 30 MHz (−3 dB).
2 mV/div	DC: DC to 20 MHz (−3) dB). AC: 5 Hz to 20 MHz (−3 dB).
Rise Time	11.7 ns or less, 17.5 ns or less at 2 mV/div sensitivity.
Overshoot	3% or less (100 kHz square wave).
Input Impedance	1 MΩ, ±2%, shunted by 23 pF, ±3 pF.
Non-Distorted Maximum Amplitude	More than 8 div, DC to 30 MHz.
Maximum Input Voltage	300 V (dc + ac peak), 600 V p-p.
Operating Modes	CH A, CH B, DUAL, ADD, and subtract (using CH B invert).
Alternate-Chop Selection	Switch selectable at sweep time of 1 ms/div and slower. Always alternate at sweep time of 0.5 ms/div and faster, and with ALT trigger source selection.
Chop Frequency	Approximately 200 kHz.
Channel B Polarity	Normal or inverted.
Channel Separation	60 dB minimum.

HORIZONTAL AMPLIFIER (input thru CH B)

X-Y Operation	With SWEEP TIME/DIV switch in CH B Position, CH A input becomes Y axis (vertical) and CH B input becomes X axis (horizontal).
Deflection Factor	Same as vertical amplifier.
Input Impedance	Same as vertical amplifier.
Maximum Input Voltage	Same as vertical amplifier.
Frequency Response	DC: DC to 2 MHz (−3 dB). AC: 5 Hz to 2 MHz (−3 dB).
X-Y Phase Difference	3° or less at 100 kHz.

TIME BASE

Type	Normal: triggering sweep. Automatic: sweep free runs in absence of trigger, reverts to triggered sweep in presence of trigger. Single: when triggered, one sweep is generated. Manually reset.
Sweep Time	0.2 μs/div to 0.5 s/div ±3% in 20 ranges, in 1-2-5 sequence. Vernier control provides fully adjustable sweep time between steps.
Sweep Magnification	X5 (five times) ±10%. Extends maximum sweep rate to 40 ns/div.
Linearity	±3% all ranges (±10% on 0.5 μs/div and 0.2 μs/div range at 5X magnification).

DELAYED SWEEP

Delay Time	1 μs to 100 ms in 5 ranges with vernier adjustment.
Intensity Modulation	INTEN switch allows portion of sweep after delay to be intensified.

Independent Delay	With ALT triggering source, channel A or channel B sweep can be independently delayed.
Delay Jitter	Less than 1 part in 10,000.

TRIGGERING

Source	Alternate, channel A, channel B, line (50/60 Hz power line), and external.
Type	Normal, automatic, and single.
Slope	Positive or negative.
Level	Continuously variable or fixed. In FIX mode, level is automatically fixed at center of sync waveform.
Hold Off	Continuously variable from NORM to more than 10 times (MAX).
Coupling	AC, LF reject, HF reject, DC.
Video	FRAME-LINE switch permits triggering from horizontal (LINE) or vertical (FRAME) sync pulses of composite video signal.
Maximum External Trigger Voltage	50 V (dc + ac peak).

TRIGGER SENSITIVITY

Coupling	Bandwidth	Minimum Trigger Voltage INT (div)	Minimum Trigger Voltage EXT (V p-p)
AC	20 Hz to 25 MHz	0.5	1
	10 Hz to 30 MHz	1	5
DC	DC to 25 MHz	0.5	1
	DC to 30 MHz	1	5
FIX	40 Hz to 25 MHz	0.5	1
	20 Hz to 30 MHz	1	5
LF Rej:	Attenuate below 10 kHz.		
HF Rej:	Attenuate above 100 kHz.		

Z-AXIS INPUT (Intensity Modulation)

Sensitivity	2 V p-p minimum (TTL compatible). Positive voltage increases brightness, negative voltage decreases brightness.
Usable Frequency Range	DC to 5 MHz.
Input Impedance	10 kΩ.
Maximum Input Voltage	50 V (dc + ac peak).

POWER REQUIREMENTS

Input	120/240 VAC, 50/60 Hz, 28 watts.
Regulation	105 to 130 VAC.

OTHER SPECIFICATIONS

Trace Rotation	Electrical, adjustable from front panel.
CRT	140 mm rectangular CRT (approx. 5″), internal 8 × 10 division graticule, 1 division = 9.5 mm.
Acceleration Voltage	6 kV.
Calibration Voltage	0.5 V p-p ± 1% square wave; positive polarity, reference level 0V. 1 kHz ± 3%.
Dimensions (HWD) without Handle	19 × 26 × 37.5 cm (7-3/8 × 10-1/8 × 14-3/4″).
Weight	8.6 kg 19 lbs.).

PROBES

Input Impedance	10:1 = 10 megohm. Direct = 1 megohm.
Connector	BNC male.
Frequency Response	100 MHz.

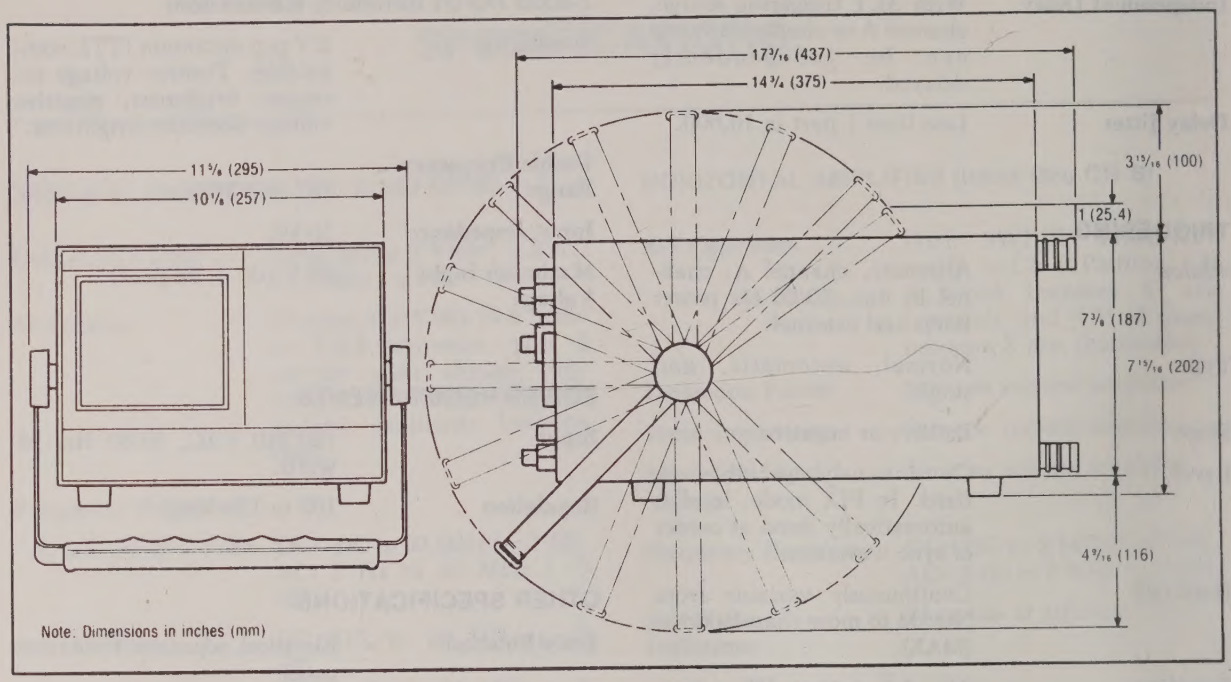

Fig. 1. Dimensional Drawing

CONTROLS AND INDICATORS

All pushbutton switches on this oscilloscope are alternate action type. Press once to engage (button stays in). Press again to release (button returns to out position).

GENERAL CONTROLS (1 - 10)

1. **MODE Switch.** Four-position lever switch; selects the basic operating modes of the oscilloscope.

   CH A Only the input signal to channel A is displayed as a single trace.

   CH B Only the input signal to channel B is displayed as a single trace.

   DUAL Dual-trace operation; both the channel A and channel B input signals are displayed on two separate traces.

   ADD The waveforms from channel A and channel B inputs are added and the sum is displayed as a single trace. When the CH B POLARITY button is engaged (INV), the waveform from channel B is subtracted from the channel A waveform and the difference is displayed as a single trace.

2. **TRACE ROTATION Control.** Electrically rotates trace to horizontal position.

3. **ASTIG Adjustment.** Astigmatism adjustment provides optimum spot roundness when used in conjunction with FOCUS and INTENSITY controls. Very little readjustment of this control is required after initial adjustment.

4. **FOCUS Control.**

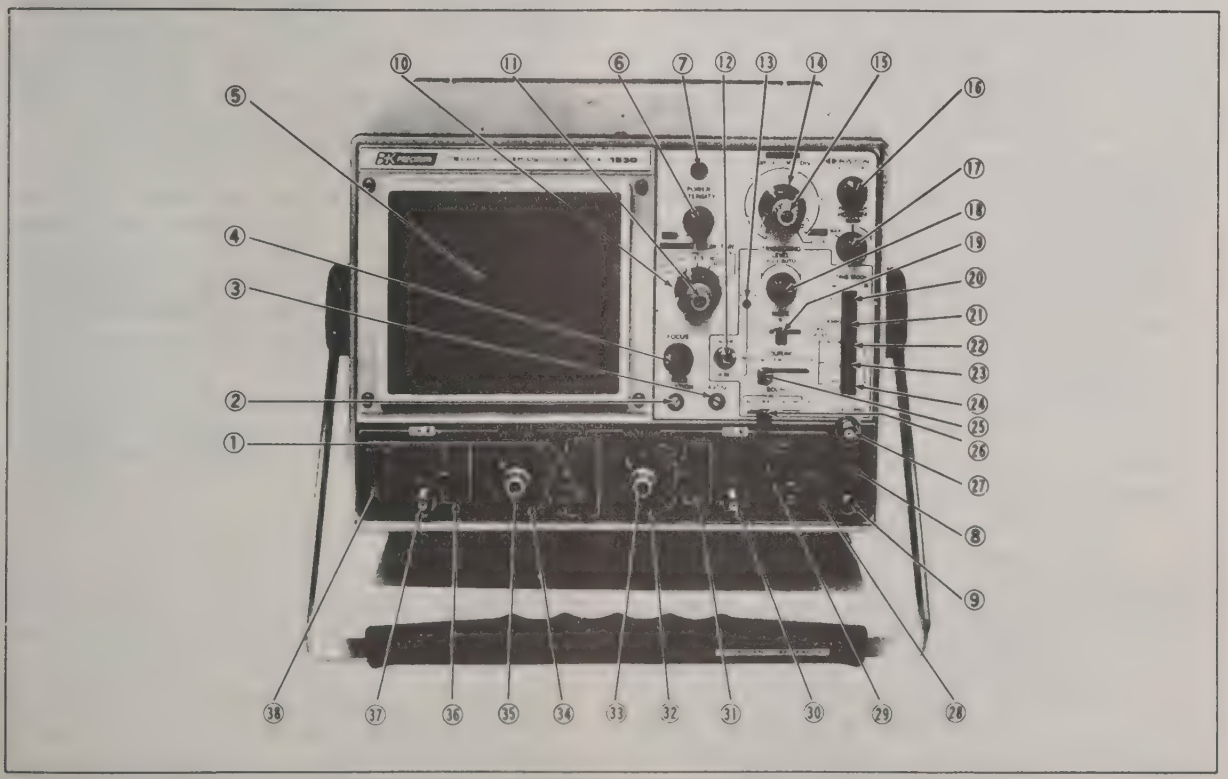

Fig. 2. Front panel controls and indicators

5. **Cathode Ray Tube (CRT).** This is the screen on which the waveforms are viewed. This rectangular CRT has in internal 8 x 10 division graticule scale which reduces parallax error to minimum.
6. **INTENSITY Control.** Fully counterclockwise rotation of this control (OFF position) turns off oscilloscope. Clockwise rotation turns on oscilloscope. Further clockwise rotation of the control increases the brightness of the trace.
7. **POWER Indicator.** Glows when oscilloscope is turned on.
8. **CAL 1 kHz ⎍ 0.5 V p-p Terminal.** Provides 1 kHz, 0.5-volt peak-to-peak square wave signal. This is useful for probe compensation adjustment and a general check of oscilloscope calibration accuracy.
9. **⏚ Terminal/Binding Post.** Earth and chassis ground.

SWEEP AND TRIGGERING CONTROLS (10 - 27)

10. **DELAY TIME Switch.** Range selector switch permits coarse selection of delay time for delayed sweep operation (this control has no effect unless one or more of the TRIG DELAY buttons is engaged . . . INTEN, CH A DLY'D, or CH B DLY'D). Five ranges of 1 to 10μs, 10 to 100 μs, .1 to 1 ms, 1 to 10 ms, and 10 to 100 ms.
11. **Delay Time VARIABLE Control.** Fine adjustment of delay time within selected range. Fully counterclockwise rotation is minimum delay time, clockwise rotation increases delay time.
12. **SINGLE Switch.** Three-position toggle switch with the following positions:

    NORM Normal sweep, used for all types of operation except single sweep.

    center

    RESET This is a momentary action position; switch returns to center position when released. Enables single sweep operation. A single sweep will begin when the next sync trigger occurs. After a single sweep, switch must be momentarily RESET to enable next single sweep. When held in RESET position, spot illumination brightens the entire CRT screen to accentuate the graticule scale for waveform photographs.
13. **Single READY Indicator.** Lights to indicate single sweep operation is ready for triggering. Lights when RESET switch is operated and goes off when single sweep is completed.
14. **SWEEP TIME/DIV Switch.** Horizontal coarse sweep time selector. Selects calibrated sweep times of 0.2 μs/div (microsecond per division) to 0.5 s/div in 20 steps when sweep time VARIABLE control is set to CAL position (fully clockwise). In the CH B position, this switch disables the internal sweep generator and permits the CH B input to provide horizontal deflection (X-Y operation).
15. **Sweep Time VARIABLE Control.** Fine sweep time adjustment. In the extreme clockwise (CAL) position the sweep time is calibrated.
16. **◄►POSITION Control.** Rotation adjusts horizontal position of trace (both traces in DUAL mode). Push-pull switch selects 5X magnification (PULL 5X MAG) when pulled out; normal when pushed in.
17. **HOLDOFF Control.** Rotation adjusts holdoff time (trigger inhibit period beyond sweep duration). Fully counterclockwise rotation is NORM, clockwise rotation increases holdoff period. Push-pull switch selects chop or alternate method of dual-trace generation; chop when pulled out (PULL CHOP), alternate when pushed in (except alternate method is always selected when SOURCE switch is in ALT position).
18. **LEVEL Control.** Trigger level adjustment determines point on waveform where sweep starts. Rotation in (−) direction selects more negative point of triggering, and rotation in (+) direction selects more positive point of triggering. Push-pull switch selects automatic triggering when pulled out (PULL AUTO). With automatically triggering, a sweep is generated automatically (free runs) in the absence of trigger signal; reverts to triggered sweep operation in the presence of adequate trigger signal.
19. **SLOPE Switch.** Two-position lever switch with the following positions:

    (+) Sweep is triggered on positive-going slope of waveform, or with positive sync pulse of composite video waveform.

    (−) Sweep is triggered on negative-going slope of waveform, or negative sync pulse of composite video waveform.

20. **FIX-NORM Button.** In the FIX position (button engaged), the triggering level is automatically fixed at the center of the triggering waveform, regardless of the position of the LEVEL control. In the NORM position, (button released), variable triggering level is enabled.

21. **FRAME-LINE Button.** In the FRAME position (button engaged), vertical sync pulses of a composite video signal are selected for triggering. In the LINE position (button released), horizontal sync pulses of a composite video signal are selected for triggering. The LINE position is also used for all non-video waveforms.

22. **INTENsify Button.** When this button is engaged, the first position of the trace(s) is of normal intensify, and the delayed sweep portion is brighter, or intensified. The beginning of the brighter portion. identifies the starting point of delayed sweep. The delay time period is variable with the DELAY TIME controls (10 and 11). Normal nonintensified trace when switch is OFF (button released).

23. **CH A DLY'D Button.** When this button is engaged, the beginning of the channel A trace is delayed by the period selected with the DELAY TIME controls. Normal non-delayed trace when switch is OFF (button released).

24. **CH B DLY'D Button.** When this button is engaged, the beginning of the channel B trace is delayed by the period selected with the DELAY TIME controls. Normal non-delayed trace when switch is OFF (button released).

25. **COUPLING Switch.** Four-position lever switch with the following positions:

    AC Trigger is ac coupled. 10 Hz to 30 MHz response.

    LF Rej Triggering below 10 kHz is attenuated.

    HF Rej Triggering above 100 kHz is attenuated.

    DC Trigger is dc coupled. DC to 30 MHz response.

26. **SOURCE Switch.** Five-position lever switch selects triggering source for the sweep, with the following positions:

    ALT Alternate triggering in DUAL mode; channel A trace is triggered by channel A signal and channel B trace is triggered by channel B signal. Scope operates in alternate sweep method regardless of setting of PULL CHOP switch.

    In CH A and ADD mode, sweep is triggered by channel A signal.

    In CH B mode, sweep is triggered by channel B signal.

    CH A Sweep is triggered by channel A signal regardless of MODE selection.

    CH B Sweep is triggered by channel B signal regardless of MODE selection.

    LINE Sweep is triggered by line voltage (60 Hz in USA).

    EXT Sweep is triggered by signal applied to EXT TRIG jack.

27. **EXT TRIG Jack.** Input terminal for external trigger signal.

CHANNEL B CONTROLS (28 - 33)

28. **CH B POLARITY Button.** In the NORM position (button released), the channel B signal is noninverted. In the INV position (button engaged), the channel B signal is inverted. In the ADD mode, and this switch in INV, the channel B signal is subtracted from the channel A signal and the difference is displayed as a single trace.

29. **POSITION Control.** Rotation adjusts vertical position of channel B trace. In X-Y operation rotation adjusts horizontal position of display. Push-pull switch (PULL 5►2 mV) selects channel B sensitivity when VOLTS/DIV switch is set to most sensitive range. Pull for 2 mV/div sensitivity, push for 5 mV/div sensitivity.

30. **INPUT Jack.** Vertical input for channel B trace in normal sweep operation. External horizontal input in X-Y operation.

31. **AC-GND-DC Switch.** Three-position lever switch which operates as follows:

    AC Blocks dc component of channel B input signal.

    GND Opens signal path and grounds input to vertical amplifier. This provides a zero-signal base line, the position of which can be used as a reference when performing dc measurements.

    DC Direct input of ac and dc component of channel B input signal.

32. **VOLTS/DIV Switch.** Vertical attenuator for channel B; provides step adjustment of vertical sensitivity. When VARIABLE control (33) is set to CAL, vertical sensitivity is calibrated in 10 steps from 5 V/div to 5 mV/div (2 mV/div when POSITION control is pulled). In X-Y operation, this control provides step adjustment of horizontal sensitivity.

33. **VARIABLE Control.** Rotation provides fine control of channel B vertical sensitivity. In the fully clockwise (CAL) position, the vertical attenuator is calibrated. In X-Y operation, this control becomes the fine horizontal gain control.

CHANNEL A CONTROLS (34 - 38)

34. **VOLTS/DIV Switch.** Vertical attenuator for channel A; provides step adjustment of vertical sensitivity. When VARIABLE control (35) is set to CAL, vertical sensitivity is calibrated in 10 steps from 5 V/div to 5 mV/div (2 mV/div when POSITION control is pulled).

35. **VARIABLE Control.** Rotation provides fine control of channel A vertical sensitivity. In the fully clockwise (CAL) position, the vertical attenuator is calibrated.

36. **AC-GND-DC Switch.** Three-position lever switch which operates as follows:

    AC Blocks dc component of channel A input signal.

    GND Opens signal path and grounds input to vertical amplifier. This provides a zero-signal base line, the position of which can be used as a reference when performing dc measurements.

    DC Direct input of ac and dc component of channel A input signal.

37. **INPUT Jack.** Vertical input for channel A trace. Vertical input for X-Y operation.

38. **POSITION Control.** Rotation adjusts vertical position of channel A trace. In X-Y operation, rotation adjusts vertical position of display. Push-pull swith (PULL 5►2 mV) selects channel A sensitivity when VOLTS/DIV switch is set to most sensitive range. Pull for 2 mV/div sensitivity, push for 5 mV/div sensitivity.

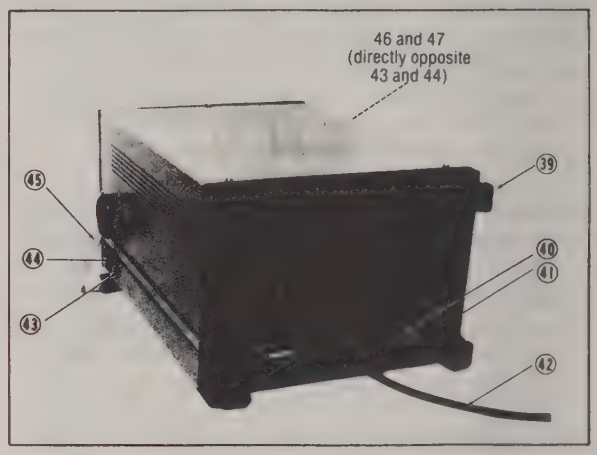

Fig. 3. Rear and side panel facilities.

ADDITIONAL FACILITIES (See Fig. 3)

39. **Cord Wrap/Feet.** Support oscilloscope in vertical position (face up) and serve as cord wrap for storing power cord.

40. **Fuse Holder.**

41. **Z AXIS INPUT Jack.** External intensity modulation input.

42. **AC Power Cord.**

43. **VR108. CH B STEP ATT. BAL Control** (under rubber plug). Screwdriver adjustment for channel B trace step attenuator balance.

44. **VR106. CH B VARI. BAL Control** (under rubber plug). Screwdriver adjustment for channel B trace vertical dc balance.

45. **Combination Carrying Handle and Tilt Stand.** When the handle is folded upward, the oscilloscope rests on rubber feet. When the handle is folded downward, it elevates the front of the oscilloscope to a convenient viewing angle. Press in both pivot points to unlock and rotate the handle. Handle locks at each 22½° angle of rotation.

46. **VR103. CH A STEP ATT. BAL Control** (under rubber plug). Screwdriver adjustment for channel A trace step attenuator balance.

47. **VR101. CH A VARI. ATT. BAL Control** (under rubber plug). Screwdriver adjustment for channel A trace vertical dc balance.

OPERATING INSTRUCTIONS

PRECAUTIONS

Safety

WARNING

The following precautions must be observed to prevent electric shock.

1. When this oscilloscope is used to make measurements in equipment that contains high voltage, there is always a certain amount of danger from electric shock. The person using the oscilloscope in such conditions should be a qualified electronics technician or otherwise trained and qualified to work in such circumstances. Observe the "Test Instrument Safety" recommendations listed on the inside front cover of this manual.
2. The ground wire of the 3-wire ac power plug places the chassis and housing of the oscilloscope at earth ground. Do not attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard.
3. One of the most commonly encountered shock hazards is testing of "hot chassis" transformerless ac-powered equipment (see item 4 on the inside front cover for a full explanation of the hazard). Never attempt to make oscilloscope measurements in such equipment without first connecting an isolation transformer between the ac power line and the equipment under test. To be on the safe side, treat all equipment as "hot chassis" unless you are sure it has an isolated chassis or earth ground chassis.

Equipment Protections

CAUTION

The following precautions will help avoid damage to the oscilloscope.

1. Never allow a small spot of high brillance to remain stationary on the screen for more than a few seconds. The screen may become permanently burned. A spot will occur only when the scope is set up for X-Y operation and no signal is applied. Either reduce the intensity so the spot is barely visible, switch back to normal sweep operation when no signal is applied, or set up the scope for spot blanking.
2. Never cover the ventilating holes in the side of the oscilloscope, as this will increase the operating temperature inside the case.
3. Never apply more than the rated 300 volts dc + ac peak or 600 volts peak-to-peak (212 volts rms for sine wave) to the oscilloscope inputs. When the probes are set for 10:1 attenuation, the voltage at the scope input is only 1/10 of that at the point of measurement, however, do not exceed the 600 volts dc + ac peak probe rating at the point of measurement.
4. Always connect a cable from the earth ground (⏚) jack of the oscilloscope to the chassis of the equipment under test. Without this precaution, the entire current for the equipment under test may be drawn through the probe clip leads under certain circumstances. Such conditions could also pose a safety hazard, which the ground cable will prevent.
5. The probe ground clips are at earth ground and should be connected only to the common of the equipment under test. To measure with respect to any point other than the common, use the "Differential Voltage Measurement" technique, with the Channel A probe to the point of reference and the Channel B probe to the point of measurement.

OPERATING TIPS

The following recommendations will help obtain the best performance from the oscilloscope.

1. Always use the probe ground clips for best results. Do not use an external ground wire in lieu of the probe ground clips, as undesired signals may be introduced.

2. Operation adjacent to equipment which produces strong ac magnetic fields should be avoided where possible. This includes such devices as large power supplies, transformers, electric motors, etc., that are often found in an industrial environment. Strong magnetic fields can exceed the practical CRT magnetic shielding limits and result in interference and distortion.

3. Probe compensation adjustment matches the probe to the input of the scope. For best results, compensation of both probes should be adjusted initially, then the same probe always used with channel A and channel B respectively. Probe compensation should be readjusted whenever a probe from a different scope is used, or the channel A and B probes are interchanged. Adjust the compensation trimmer on each probe for the best quality waveshape (minimum overshoot, rounding off, and tilt), while observing the calibration square wave from the CAL 1 kHz ⎍ 0.5 V p-p terminal.

4. Occasionally check trace rotation, dc balance, astigmatism, and calibration accuracy of the scope using the procedures found in the OPERATOR MAINTENANCE section of this manual.

INITIAL STARTING PROCEDURE

Until you familiarize yourself with the use of all controls, the following procedure may be used to standardize the initial setting of controls as a reference point and to obtain a trace on the CRT in preparation for waveform observation.

1. Set INTENSITY control to OFF (fully counterclockwise).

2. Connect power cord to a 120-volt, 50/60 Hz outlet. Operation from 100 volts, 220 volts, or 240 volts, 50/60 Hz ac is also possible if the oscilloscope is first set up for such operation. Procedures are given in the SERVICING portion of this manual.

3. Set CH A POSITION control, CH B POSITION control and ◄ ►POSITION control to the centers of their ranges. The push-pull switch on each of these controls should be pushed in.

4. Set CH A AC-GND-DC switch and CH B AC-GND-DC switch to the GND positions.

5. Set the SINGLE switch to the NORM position.

6. Set the MODE switch to the DUAL position for dual-trace operation. It will be desirable to display both traces when making the centering adjustments in step 13.

7. In triggered sweep operation, the trace remains at rest and is blanked until an input signal is applied for triggering. In automatic sweep operation, a trace is generated without an input signal. Since no input signal will be applied initially, select automatic sweep by pulling outward on the triggering LEVEL control (PULL AUTO).

8. Set SWEEP TIME/DIV switch to 1 mS position. Any position except CH B may be used, but 1 mS is a good starting point.

9. Turn on oscilloscope by turning INTENSITY control clockwise. The POWER pilot light will glow.

10. Wait a few seconds for the cathode ray tube (CRT) to warm up. Two traces should appear on the face of the CRT.

11. If no trace appears, increase (clockwise) the INTENSITY control setting until the trace is easily observed.

12. Adjust FOCUS control and INTENSITY control for the thinnest, sharpest trace.

13. Readjust POSITION controls if necessary, to position the traces for convenient viewing, with the channel A trace above the channel B trace and with both traces starting at the left edge of the graticule scale.

14. Check for proper adjustment of TRACE ROTATION and ASTIG controls and dc balance adjustments as described in the OPERATOR MAINTENANCE section of this manual. These adjustments require checking only periodically.

15. Controls may be set to the following positions as a starting point for most waveform observation.

    SINGLE switch unchanged from step 5 (NORM position).

    SWEEP TIME/DIV switch unchanged from step 8 (1 mS), and sweep time VARIABLE control to CAL (fully clockwise).

    FOCUS and INTENSITY controls unchanged from step 12.

    POSITION controls unchanged from step 13.

    MODE switch to CH B for single-trace operation or DUAL for dual-trace operation.

    CH A and CH B AC-GND-DC switches to AC.

CH A and CH B VOLTS/DIV controls to 5V positions, and VARIABLE controls to CAL (fully clockwise).

CH B POLARITY button to NORM (out).

SOURCE switch to ALT.

COUPLING switch to AC.

SLOPE switch to "+".

Triggering LEVEL control centered and push-pull switch (PULL AUTO) pushed in. The trace(s) will disappear until adequate input signal is applied for sweep triggering.

HOLDOFF control to NORM, and push-pull switch (PULL CHOP) pushed in.

All TRIG MODE pushbuttons to out positions, as follows:

FIX-NORM to NORM
FRAME-LINE to LINE
INTEN, CH A DLY'D and CH B DLY'D to OFF

DELAY TIME switch and delay time VARIABLE control may be left in any position.

16. The oscilloscope is now ready for waveform observation.

WAVEFORM OBSERVATION

Single Trace

Either channel A or channel B can be used for single-trace operation. The advantage of using channel B is that the polarity of the observed waveform can be inverted, if desired, with the CH B POLARITY switch. For convenience, channel B is used in the following instructions:

1. Performs the steps of the INITIAL STARTING PROCEDURE with the MODE switch in the CH B position. Then connect the probe cable to the CH B INPUT jack.
2. For all except very low-amplitude waveforms, the probes are set for 10:1 attenuation. For very low-amplitude waveforms (below 20 millivolts peak-to-peak), set the probe for DIRECT. The 10:1 setting, with its higher input impedance and lower shunting capacitance, should be used when possible to decrease circuit loading.
3. Set CH B AC-GND-DC switch to AC for measuring only the ac component (this is the normal position for most measurements and must be used if the point being measured includes a large dc component). Use the DC position for measuring both the ac component and the dc reference, and any time a very low frequency waveform (below 10 Hz) is to be observed. The GND position is required only when a zero-signal ground reference is required, such as for dc voltage readings.
4. Connect ground clip of probe to chassis or common of the equipment under test. Connect the tip of the probe to the point in the circuit where the waveform is to be measured.
5. If no trace appears, turn the CH B VOLTS/DIV switch clockwise until a trace does appear. If the switch is rotated all the way to the 5 mV range and no trace has appeared, pull the CH B POSITION control knob (PULL 5►2 mV). This increases vertical sensitivity to 2 mV per division.

NOTE

The initial 5V setting of the VOLTS/DIV control recommended in the INITIAL STARTING PROCEDURE offers the greatest protection against accidental overvoltage when the probe is first touched to the point of measurement. However, initial sensitivity with a 10:1 probe is 50 volts per division, and there usually won't be adequate signal for sweep triggering. Turning the VOLTS/DIV switch clockwise increases vertical sensitivity. When sensitivity is increased adequately for the input signal to produce 1 division or more vertical deflection (with triggering LEVEL control centered), the sweep is triggered and a trace appears. If no trace is obtainable, refer to the following TRIGGERING procedures.

6. Set CH B VOLTS/CM switch and VARIABLE control to a position that gives 2 to 6 divisions of vertical deflection. The display on the screen will probably be unsynchronized. Refer to TRIGGERING procedures below for adjusting synchronization and sweep speed to obtain a stable display showing the desired number of waveforms.

Dual Trace (Refer to Fig. 4)

In observing simultaneous waveforms on channel A and B, the waveforms are usually related in frequency, or one of the waveforms is synchronized to the other, although the basic frequencies are different. One common application is in digital circuits where virtually all waveforms are related to a master "clock" frequency. If the two waveforms have no phase or frequency relationship, there is seldom reason to observe both waveforms simultaneously.

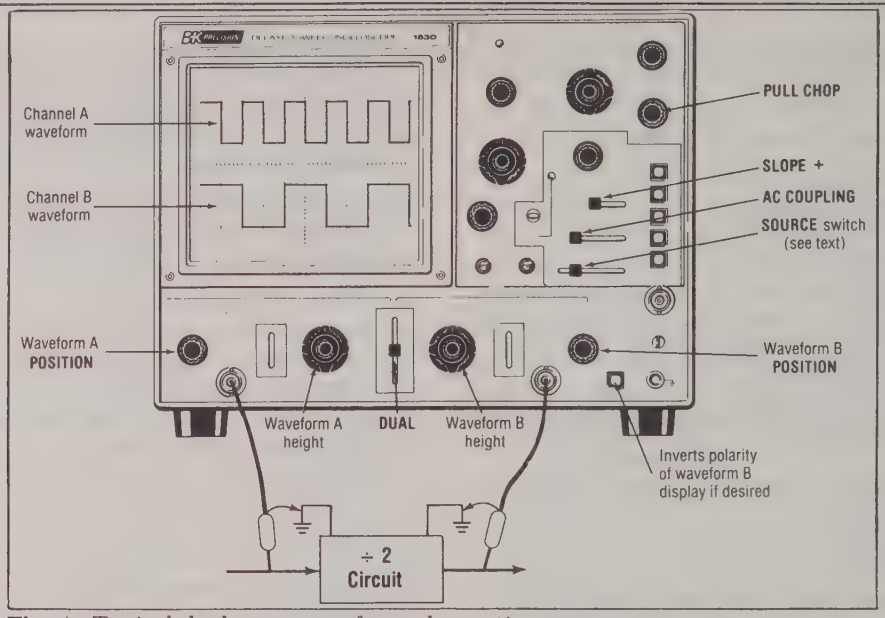

Fig. 4. Typical dual-trace waveform observation.

To display two waveforms simultaneously for observation use, the following procedure:

1. Perform the steps of the INITIAL STARTING PROCEDURE.
2. Connect oscilloscope probe cables to both the CH A and CH B INPUT jacks.
3. For all except very low-amplitude waveforms, the probes are set for 10:1 attenuation. For very low-amplitude waveforms (below 20 millivolts peak-to-peak), set the probes for DIRECT. The 10:1 setting, with its higher input impedance and lower shunting capacitance, should be used when possible to decrease circuit loading.
4. Set CH A and CH B DC-GND-AC switches to AC for measuring only the ac component (this is the normal position for most measurements and must be used if the point being measured includes a large dc component). Use the DC position for measuring both ac component and the dc reference, and any time a very low frequency waveform (below 10 Hz) is to be observed. The GND position is required only when a zero-signal ground reference is required, such as for dc voltage readings.
5. Connect the ground clips of the probes to the chassis or common of the equipment under test. Connect the tips of the probes to points in the circuit where the waveforms are to be measured.
6. Set MODE switch to the DUAL position. Two traces should appear on the screen.
7. If no traces appear, set the SOURCE switch to CH A and turn the CH A VOLTS/DIV switch clockwise until the traces appear. If the VOLTS/DIV switch is rotated all the way to the 5 mV range and no traces have appeared, pull the CH A POSITION control knob (PULL 5►2 mV). This increases vertical sensitivity to 2 mV/division.

NOTE

The initial 5V setting of the VOLTS/DIV switches recommended in the INITIAL STARTING PROCEDURE offers the greatest protection against accidental overvoltage when the probes are first touched to the points of measurement. However, initial sensitivity with 10:1 probes is 50 volts per division and there usually won't be adequate signal for sweep triggering. Turning the CH A VOLTS/DIV switch clockwise increases the channel A vertical sensitivity. When sensitivity is increased adequately for the input signal to produce 1 division or more vertical deflection (with triggering LEVEL control centered), the sweep is triggered and both traces appear. If no trace is obtainable, refer to the following TRIGGERING procedures.

8. Adjust CH A and CH B POSITION controls to place the channel A trace above the channel B trace, and adjust both traces to a convenient reference mark on the scale.

9. Dual-trace sweep is generated by two methods; alternate and chop. In alternate sweep operation, one sweep displays the channel A trace and the next sweep displays the channel B trace, in an alternating sequence. In chop sweep operation, the sweep is chopped at an approximate 200 kHz rate and switched between the channel A and channel B trace. The alternate method of dual-trace generation is always selected when the SOURCE switch is in the ALT position (a necessity for alternate triggering). Otherwise, the alternate or chop method of dual-trace operation may be selected at any sweep speed. The alternate-chop selection is made manually with the HOLDOFF/PULL CHOP control (pull for chop, push for alternate). The alternate method is normally used for viewing high-frequency or high-speed waveforms at sweep times of 0.5 ms/div to 0.2μs/div. The chop method is normally used for low-frequency or low-speed waveforms at sweep times of .5 second/div to 1 ms/div. If chop sweep is used at frequencies above 5 kHz (sweep time of 0.2 ms/div and faster), the chop rate becomes a significant portion of the sweep and may become visible in the displayed waveform. However, you may select alternate or chop operation at any sweep speed for special applications. For example, the only way to view simultaneous events on a dual-trace scope at any sweep speed is with chop sweep.
10. Set the VOLTS/DIV switches and VARIABLE controls for channels A and B to a position that gives 2 to 3 divisions of vertical deflection for each trace. The displays on the screen will probably be unsynchronized. Refer to TRIGGERING procedures below for adjusting synchronization and sweep speed to obtain a stable display showing the desired number of waveforms.

TRIGGERING

The Model 1530 Oscilloscope provides full versatility in the selection and adjustment of sync triggering for maximum ability to obtain a stable, jitter-free display in single-trace and dual-trace operation. The following steps are concerned with setting controls to obtain a stable, synchronized display. The proper control settings depend upon the type of waveform being observed and other factors. An explanation of the various control settings which affect synchronization of the display is given to help you select the proper settings over a wide range of conditions.

1. SOURCE Switch.

Triggered sweep operation is normally used with this oscilloscope. In triggered sweep operation, the sweep remains at rest until triggered by a sync pulse. The SOURCE switch selects the input signal that is to be used to trigger the sweep, with four INTernal sync possibilities and one EXTernal sync possibility.

a. INTernal Sync Positions.

(1) **ALTernate position.** Operates in conjunction with MODE switch to use waveform(s) being observed as sync trigger. Specifically, when MODE switch is in CH A and ADD modes the channel A input signal becomes the sync trigger, in the CH B mode, the channel B input signal becomes the sync trigger, and in the DUAL mode, the channel A and channel B input signals alternately become sync triggers for the A and B trace respectively.

IMPORTANT

The ALT position is probably the most commonly used setting of the SOURCE switch, and is very convenient for checking amplitude, observing the wave shape, or measuring the time duration of the waveform(s). However, for phase or timing comparisons between the channel A and channel B waveforms, both traces must be triggered by the *same* sync signal. Use any position *except* ALT for such measurements. Also, the ALT position selects the alternate sweep method of dual-trace genertion and cannot be used when the chop sweep method is desired. In dual-trace operation, alternate source triggering requires adequate trigger signal on both channel A and B to sustain triggered sweep. If either signal is missing or falls below the triggering threshold level, no sweep will be generated. In such cases, AUTO sweep may be selected to obtain a dual-trace display.

(2) **CH A position.** In this position, the input signal at the channel A INPUT jack becomes the trigger regardless of the position of MODE switch. Maximum trigger sensitivity at the channel A input jack is 2 millivolts peak-to-peak.

(3) **CH B position.** In this position, the input signal at the channel B INPUT jack becomes the trigger regardless of the position of MODE switch. Maximum trigger sensitivity at the channel B INPUT jack is 2 millivolts peak-to-peak.

(4) **LINE Position.** In this position, the ac line voltage powering the oscilloscope (60 Hz in USA) is used as sync triggering. This is useful for observing waveforms that are related to the power line frequency such as power supply ripple, or a common reference for phase shift measurements at various points in line frequency related circuits.

b. EXTernal Sync Position.

In this position, the input signal at the EXTernal TRIGger jack becomes the trigger. This signal must have a time or frequency relationship to the signal being observed to synchronize the display. External sync is preferred for waveform observation in many applications. For example, in digital circuits where several time-related waveforms are present, as reference phase when observing phase shift at several points in non-LINE frequency related circuits, and in signal tracing to eliminate triggering readjustment at each point of measurement.

External triggering has a minimum sensitivity of 0.5 volt, and will often trigger on signals as low as 0.1 volt. The maximum input voltage rating is 50 volts (dc + ac peak). If the external trigger signal amplitude is too high, the triggering point cannot be adjusted satisfactorily with the triggering LEVEL control. If this occurs use a 10:1 oscilloscope probe for the external sync signal to attenuate the trigger to a more suitable level. This method also extends the maximum external triggering voltage that may be used.

2. COUPLING Switch.

a. AC Position.

Most commonly used position; permits triggering from 10 Hz to over 30 MHz. Blocks dc component of sync trigger signal.

b. LF Rej Position.

Attenuates trigger signals below 10 kHz. Useful to reduce low-frequency interference such as 60 Hz hum (see Fig. 5A).

c. HF Rej Position.

Attenuates trigger signals above 100 kHz. Useful to reduce high-frequency noise (see Fig. 5B), and permits triggering from the modulation envelope of an amplitude modulated rf signal.

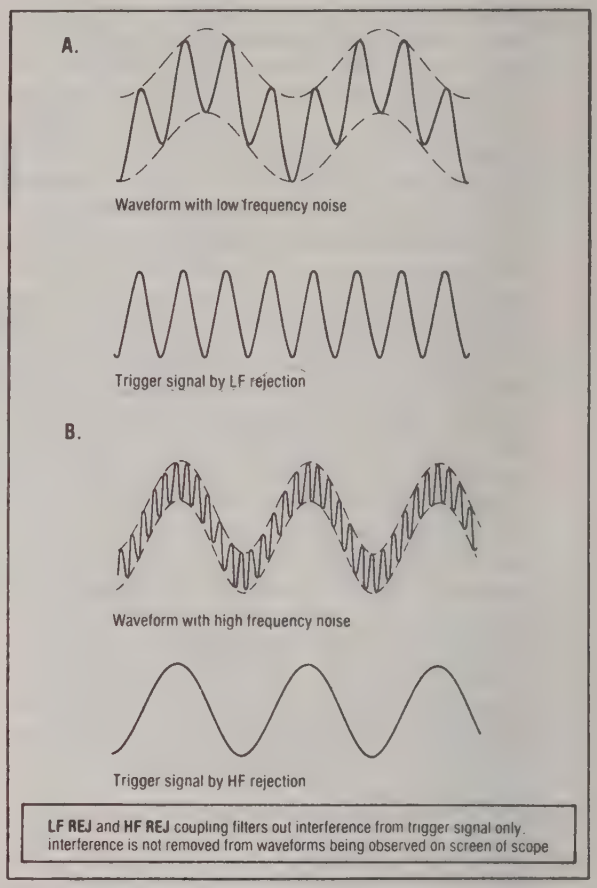
A.
Waveform with low frequency noise
Trigger signal by LF rejection
B.
Waveform with high frequency noise
Trigger signal by HF rejection
LF REJ and HF REJ coupling filters out interference from trigger signal only. interference is not removed from waveforms being observed on screen of scope

Fig. 5. Effects of LF and HF rejection in sync coupling.

d. DC Position.

Permits triggering from dc to over 30 MHz. Couples dc component of sync trigger signal. Useful for triggering from very low frequency signals (below 10 Hz), or ramp waveforms with slow repeating dc.

3. SLOPE Switch. (see Fig. 6)

a. + Position.

A sweep trigger is developed from the trigger source signal as it crosses a threshold level in a *positive-going* direction.

b. – Position.

A sweep trigger is developed from the trig-

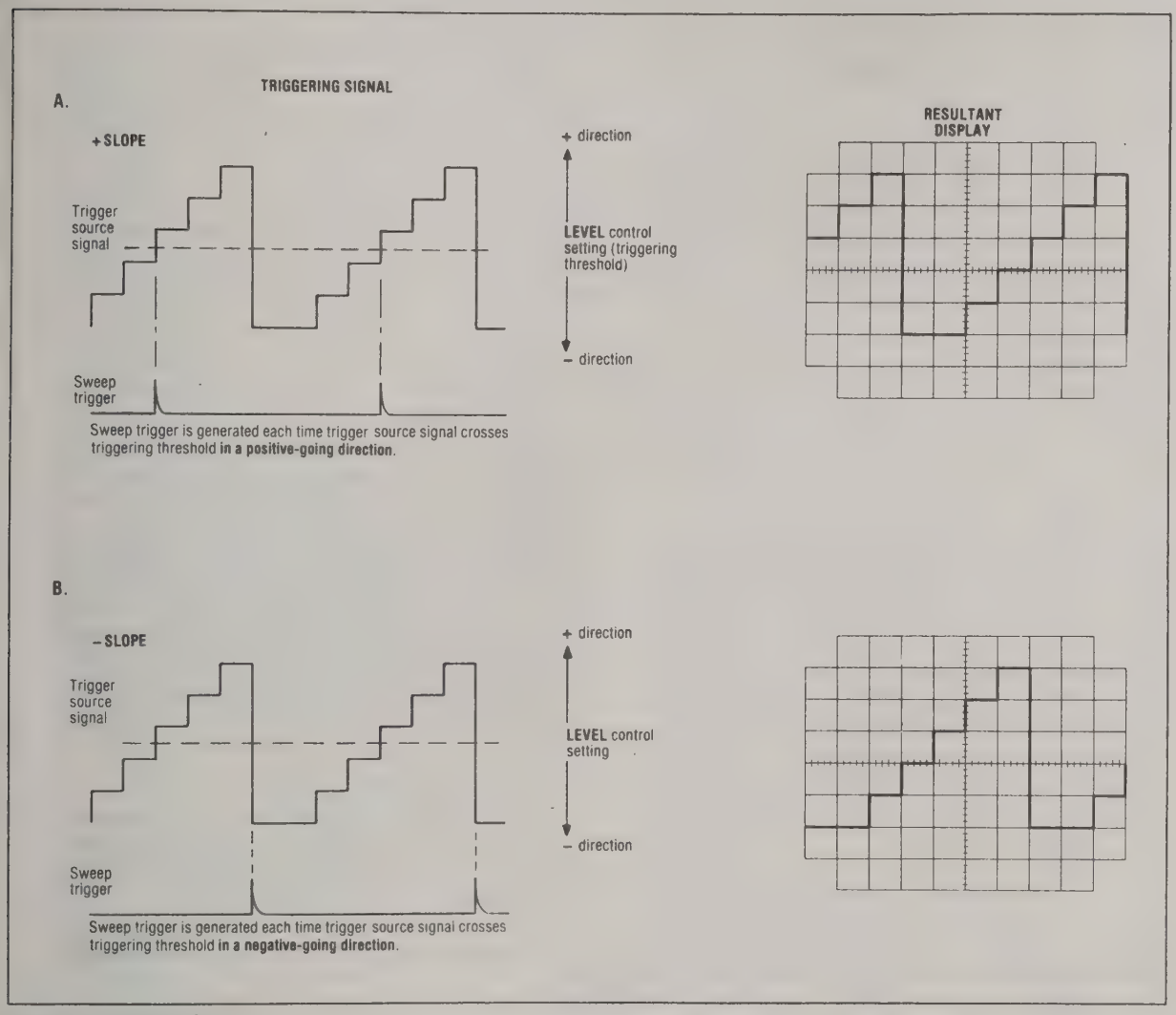

Fig. 6. SLOPE selection.

ger source signal as it crosses a threshold level in a *negative-going* direction.

4. Triggering LEVEL Control.

Rotation of the triggering LEVEL control varies the triggering threshold level as illustrated in Fig. 7. In the + direction (clockwise), the triggering threshold shifts to a more positive value, and in the – direction (counterclockwise), the triggering threshold shifts to a more negative value. When the control is centered, the threshold level is set at the approximate average of the signal used as the triggering source. Note that if the triggering LEVEL control is rotated toward its extreme + or – setting, that no sweep will be developed in the normal triggered sweep mode because the triggering threshold exceeds the peak amplitude of the sync signal.

When the triggering LEVEL control is pulled outward (PULL AUTO), automatic sweep operation is selected. In automatic sweep operation, the sweep generator free-runs to generate a sweep without a trigger signal (this is also called recurrent sweep operation), but automatically switches to triggered sweep operation if an acceptable trigger source signal is present. The AUTO position is handy when first setting up the scope to observe a waveform; it provides sweep for waveform observation until other controls can be properly set. Automatic sweep operation *must* be used for dc

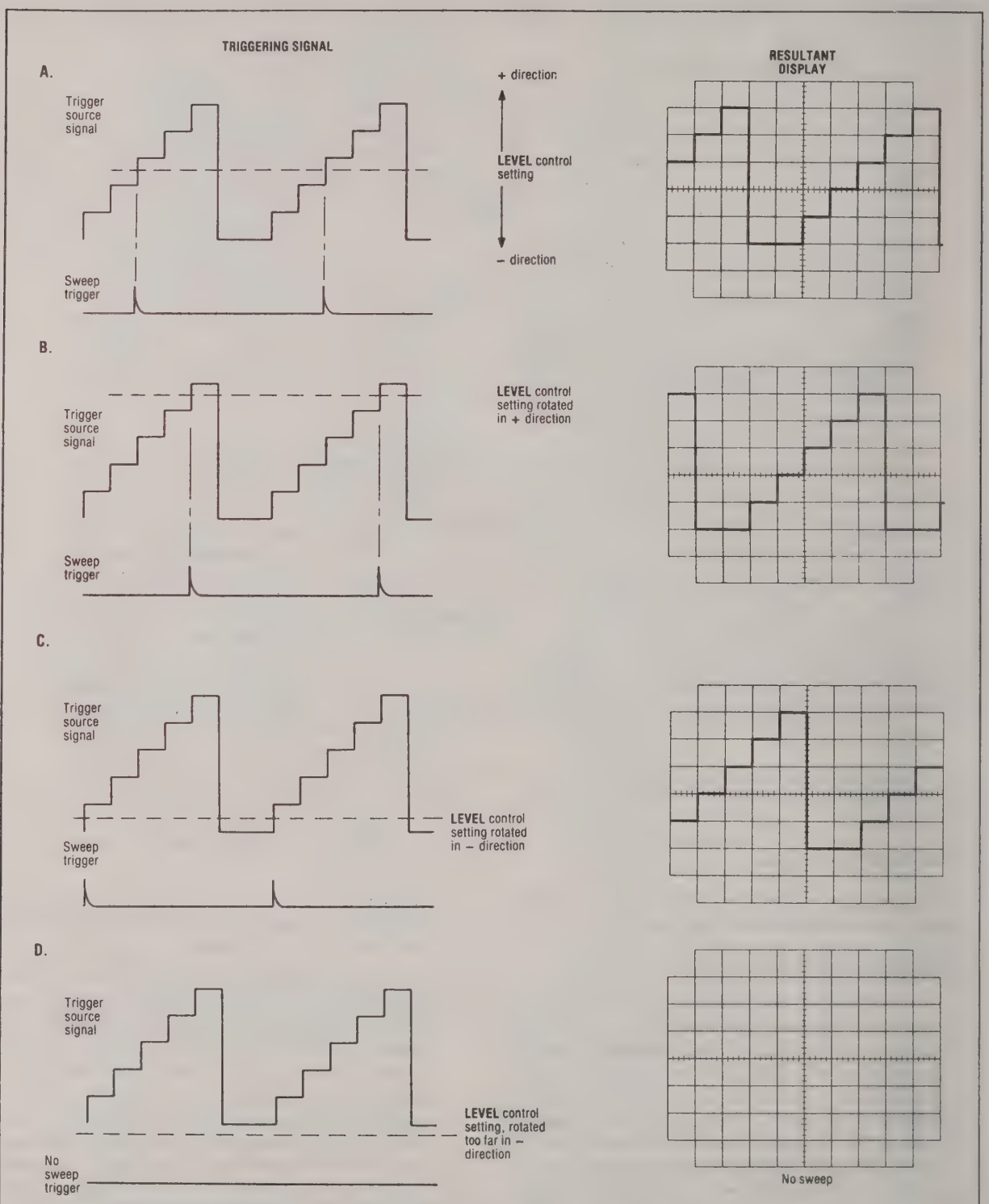

Fig. 7. Effects of varying LEVEL control setting ("+" SLOPE used in all examples).

measurements and signals of such low amplitude that they will not trigger the sweep. Typically, signals that produce even ½ division of vertical deflection are adequate for normal triggered sweep operation.

In AUTO operation, the LEVEL control still selects the triggering threshold at which the scope will switch from automatic sweep to triggered sweep operation.

The examples shown in Fig. 7 use a staircase waveform. However, any waveshape will produce a sweep trigger when it passes through the triggering threshold. Rotation of the LEVEL control adjusts the start of the sweep to almost any desired point on a waveform. On sine wave signals, the phase at which sweep begins is variable. For any type signal, the LEVEL control can be used to set an amplitude threshold which must be exceeded to obtain a sweep. This permits the oscilloscope to serve as an amplitude threshold detector, or prevents triggering by noise or an undesired portion of a waveform. When DC COUPLING is used, the dc component of the trigger source signal must also be considered when setting the triggering LEVEL control (see Fig. 8).

In dual-trace, triggered sweep operation using alternate source triggering, both signals must exceed the triggering threshold to obtain a sweep. Both traces may be displayed by switching to AUTO sweep. Examination of the display should indicate whether the channel A or channel B signal, or both, has caused the loss of triggering.

5. **HOLDOFF Control.**

A "holdoff" period occurs immediately after the completion of each sweep, and is a period during which triggering of the next sweep is inhibited. The normal holdoff period varies with the sweep rate, but is adequate to assure complete retrace and stabilization before the next sweep trigger is permitted. The HOLDOFF control allows this period to be extended by a variable amount if desired.

This control is usually set to the NORM position (fully counterclockwise) because no additional holdoff period is necessary. The HOLDOFF control is useful when a complex series of pulses appear periodically, such as in Fig. 9A. Improper sync may produce a double image as in Fig. 9B. Such a display could be synchronized with the sweep time VARIABLE control, but this is impractical because time measurements are then uncalibrated. An alternate method of synchronizing the display is with the HOLDOFF control. The sweep speed remains the same, but the triggering of the next sweep is "held off" by the duration selected by the HOLDOFF control. Turn the HOLDOFF control clockwise from the NORM position until the sweep starts at the same point of the waveform each time. At the MAX setting, the holdoff period is about 10 times greater than at the NORM setting.

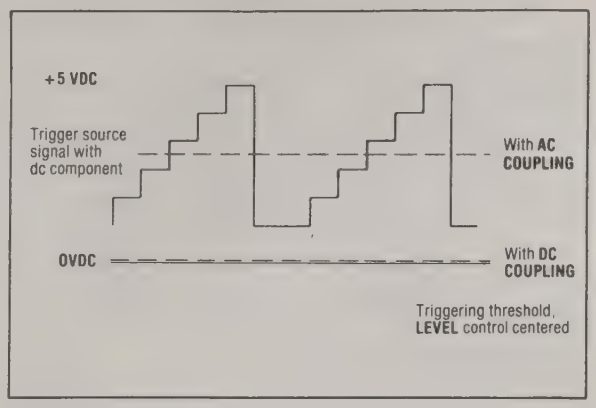

Fig. 8. Effect of COUPLING selection upon LEVEL control setting.

6. **FIX-NORM Pushbutton Switch.**

When the FIX button is engaged, the LEVEL control is bypassed and the triggering threshold is automatically "fixed" at the center of the sync

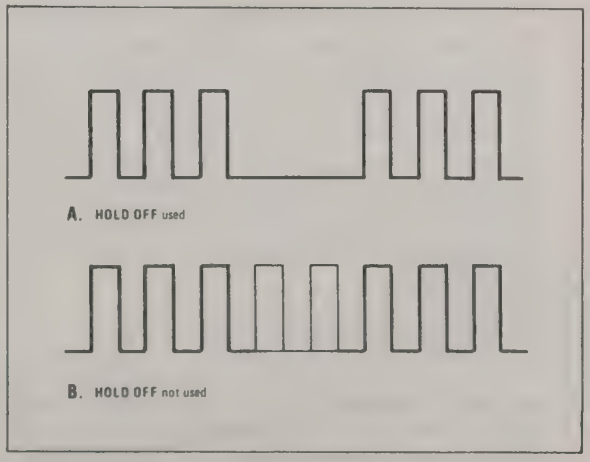

Fig. 9. Use of HOLDOFF control.

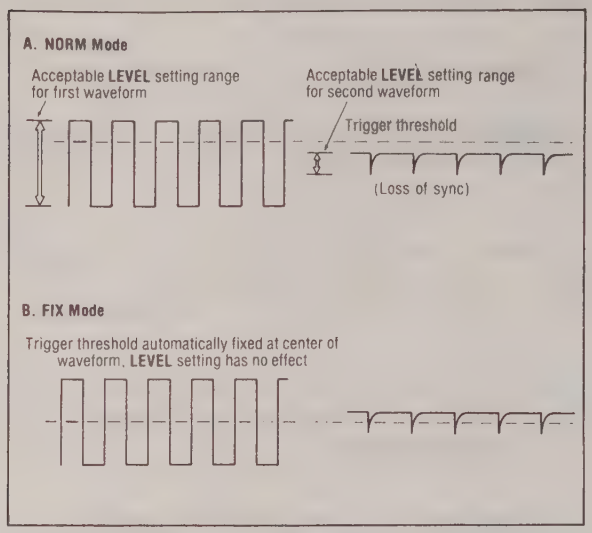
A. NORM Mode
Acceptable LEVEL setting range for first waveform
Acceptable LEVEL setting range for second waveform
Trigger threshold
(Loss of sync)
B. FIX Mode
Trigger threshold automatically fixed at center of waveform. LEVEL setting has no effect

Fig. 10. FIX mode triggering.

trigger waveform. This is often very handy because it eliminates the need to continually readjust the LEVEL control when making waveform measurements at several points which may be of different amplitude and waveshape, or when waveform amplitudes vary throughout a series of tests. Fig. 10 shows an example of how sync may be lost when making consecutive waveform measurements in the NORM mode, but sync is maintained in the FIX mode. The same principle applies when waveform amplitudes vary during testing. The FIX mode maintains sync over the widest possible amplitude variation. Only when the waveform amplitude becomes too low for sweep triggering is sync lost.

For most general waveform observations, the FIX mode is desirable and saves time in set-up. However, the NORM mode must be used if triggering is desired at any point *other* than the center of the waveform, or DC COUPLING of the trigger signal is desired. Even when the NORM mode is required, the FIX mode may expedite initial set-up of the waveform display. You can then switch to the NORM mode and finalize set-up with the LEVEL control.

7. FRAME-LINE Pushbutton Switch.

The FRAME-LINE switch permits selection of vertical or horizontal sync pulses for sweep triggering when viewing composite video waveforms. In the LINE position (button out), horizontal sync pulses are selected as triggers to permit viewing of horizontal lines of video. This is also the position used for viewing all non-video waveforms. In the FRAME position (button engaged), vertical sync pulses are selected as triggers to permit viewing of vertical fields and frames of video.

a. LINE Position.

A typical composite video waveform and the typical control settings for viewing horizontal lines of video are shown in Fig. 11A. The FRAME-LINE switch must be in the LINE position. In this position, the entire video signal is used as the trigger source signal. To use the horizontal sync pulses for triggering, the trigger threshold must be set so that *only the sync pulses portion* of the signal crosses the trigger threshold; *not the video portion*.

As can be seen from Fig. 11, the proper trigger threshold level is near one extreme of the waveform rather than near the center. Therefore, the FIX mode is not suitable, because it automatically fixes the trigger threshold at the center of the waveform.

At most points of measurement, a composite video signal is of the polarity shown in Fig. 11A; that is, the sync pulses are negative and the video is positive. In those cases, use "−" SLOPE and adjust the trigger LEVEL control toward the most negative setting that produces a sweep. If the waveform is taken at a circuit point where the video waveform is inverted, the sync pulses are positive and the video is negative. In those cases, use "+" SLOPE and adjust the triggering LEVEL control toward the most positive setting that produces a sweep.

DC COUPLING is preferred, and must be used when viewing a video signal from a broadcast station. The video portion of a signal from a signal from a broadcast station varies widely, and unpredictably, in average amplitude, depending upon the scene. Only the sync pulse portion of the waveform is constant in amplitude. With DC COUPLING, the amplitude excursions are with respect to the dc component at the point of measurement. The sync pulse amplitude is repetitive with respect to the dc component and stable triggering is possible. AC COUPLING is unsuitable because it centers the waveform

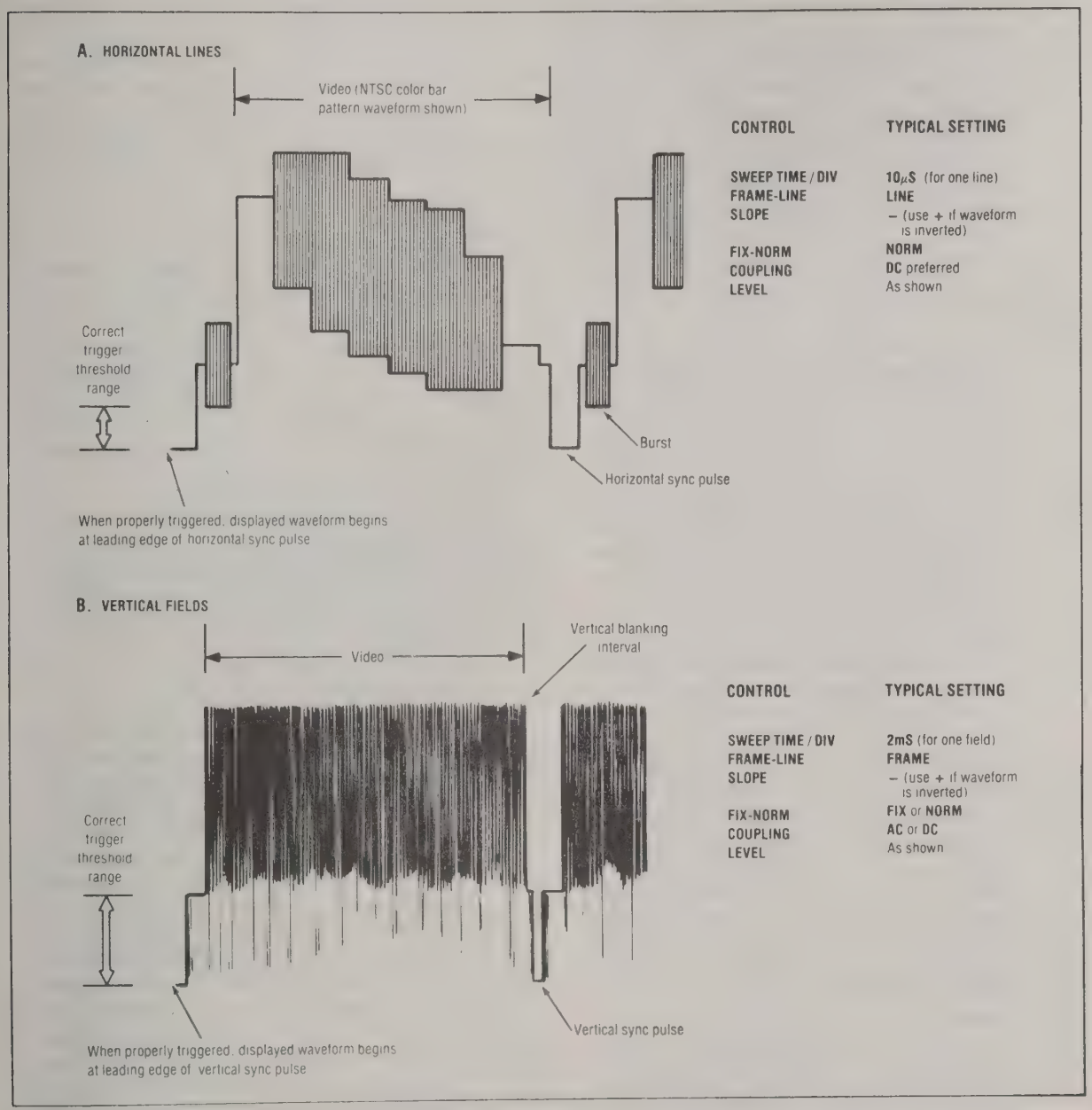

Fig. 11. Observing composite video waveforms.

about the *average* waveform amplitude of the *entire* video signal, and the average amplitude changes constantly when the video portion is included. The triggering point continually shifts and synchronization of the display is impossible. AC COUPLING may be used, if desired, when the video portion of the signal is repetitive, such as when a video pattern generator is used as the signal source. In this case, the average waveform amplitude is approximately constant except when changing from one pattern to another. Of course, even when a repetitive video pattern is used, DC COUPLING is also satisfactory. AC COUPLING is preferable only when the dc component at the point of measurement is large with respect to the video signal.

When viewing horizontal lines of video, triggering on some point other than horizontal sync pulses is possible, if desired. For example, the trigger threshold could be set to permit triggering from the burst signal. If a staircase video pattern is applied, triggering at any step of the pattern could be achieved. In addition, variable holdoff and delayed sweep operation permit close examination of any specific portion of a video signal, even one specific horizontal line out of an entire video frame.

b. **FRAME Position.**

A typical composite video waveform and the typical control settings for viewing vertical fields and frames of video are shown in Fig. 11B. The FRAME-LINE switch must be in the FRAME position. This routes the trigger source signal through a built-in sync separator circuit which detects and separates the sync pulses from the video signal. The video portion is clipped and only the sync pulses pass. The circuit then filters out the short-duration horizontal sync pulses and passes only the longer-duration vertical sync pulses.

Since none of the video portion of the waveform is coupled, the FIX mode or AC COUPLING is now permissible. However, if the oscilloscope was previously set up for viewing horizontal lines of video at the point of measurement, there is no need to change the triggering LEVEL control setting to obtain proper triggering if you wish to use the NORM mode and DC COUPLING. The SWEEP TIME/DIV must be set to a much slower rate, or course, to view entire fields or frames of video.

8. **Triggering Adjustment Procedure.**

a. **Step 1.**

Select the triggering SOURCE, COUPLING, SLOPE, and LEVEL for desired triggering as explained previously. If unsure, start with ALT source, AC coupling, + slope, NORM holdoff, NORM trigger mode, and LINE video.

b. **Step 2.**

Adjust triggering LEVEL control to obtain a synchronized display without jitter. As a starting point, the control may be rotated to any point that will produce a sweep, which is usually somewhere in the center portion of its range. The trace will disappear if there is inadequate signal to trigger the sweep, such as when measuring dc or extremely low amplitude waveforms. If no sweep can be obtained select AUTO sweep (pull the LEVEL control). If triggering from the center of the waveform is acceptable, press the FIX button.

c. **Step 3.**

Set SWEEP TIME/DIV switch and VARIABLE control for the desired number of waveforms. These controls may be set for viewing only a portion of a waveform, but the trace becomes progressively dimmer as a smaller portion is displayed. This is because the sweep speed increases but the sweep repetition rate does not change. Readjust the INTENSITY and FOCUS controls if desired.

d. **Step 4.**

After obtaining the desired number of waveforms, as in step 3, it is often desirable to make a final adjustment of the triggering LEVEL control. The control may be adjusted to start the sweep on any desired portion of the waveform.

e. **Step 5.**

For a close-up view of a portion of the waveform, pull outward on the ◄►POSITION control. This expands the sweep by a factor of five (5X magnification) and displays only the center portion of the sweep. To view a portion to the left of center, turn the ◄►POSITION control counterclockwise, and to view a portion to the right of center, turn the control clockwise. Push inward on the control to return the sweep to the normal, non-magnified condition. Greater magnification may be obtained by using delayed sweep unless the oscilloscope is already at its fastest sweep rate. Magnification up to 1000 times is practical and is generally limited only by the maximum sweep rate of 0.2 μs/division (40 ns/division with 5X MAG.) Procedures for delayed sweep operation follow.

DELAYED SWEEP OPERATION

The primary purpose of delayed sweep operation is to permit closer examination of a waveform than is otherwise possible. In an oscilloscope without delayed sweep, increasing the sweep speed to view only a portion of a waveform allows only the portion immediate-

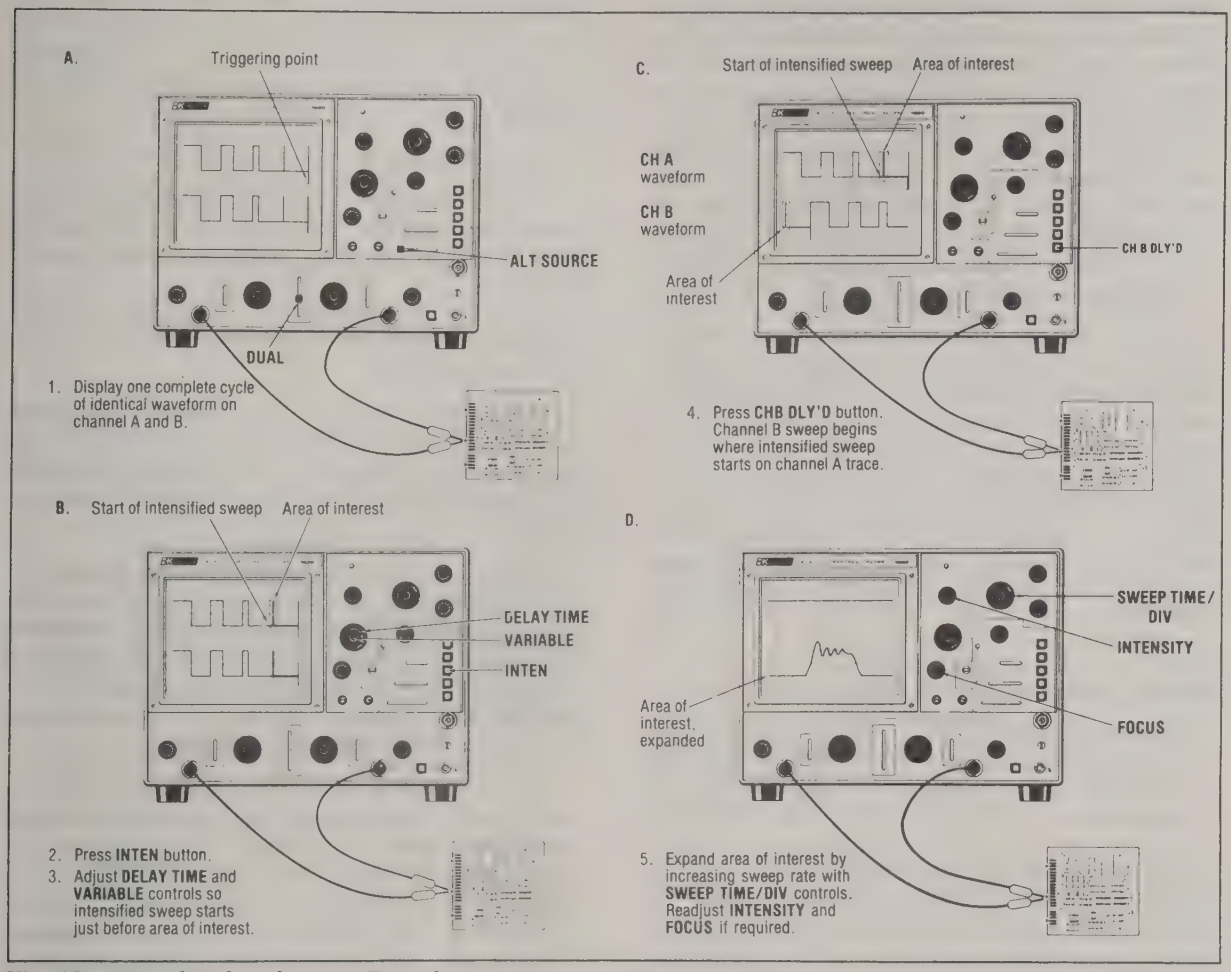
A.
Triggering point
ALT SOURCE
DUAL
1. Display one complete cycle of identical waveform on channel A and B.
B. Start of intensified sweep
Area of interest
DELAY TIME VARIABLE
INTEN
2. Press INTEN button.
3. Adjust DELAY TIME and VARIABLE controls so intensified sweep starts just before area of interest.
C. Start of intensified sweep
Area of interest
CH A waveform
CH B waveform
Area of interest
CH B DLY'D
4. Press CHB DLY'D button. Channel B sweep begins where intensified sweep starts on channel A trace.
D.
SWEEP TIME/ DIV
INTENSITY
FOCUS
Area of interest, expanded
5. Expand area of interest by increasing sweep rate with SWEEP TIME/DIV controls. Readjust INTENSITY and FOCUS if required.

Fig. 12. Typical Delayed Sweep Procedure.

ly after the triggering point to be viewed. The delayed sweep feature permits a variable delay to be inserted between the triggering point of the waveform and the start of sweep. Varying the delay period permits any portion of a waveform to be viewed, even when the waveform is greatly expanded by sharply increasing sweep speed. The delay time of this oscilloscope is variable from 1 microsecond to 100 milliseconds in five decade ranges. The low jitter of the variable delay permits sweep rates up to at least 1000 times greater than the repetition rate of the waveform being viewed, if desired, limited by the maximum sweep rate of 0.2 μs/division, or 40 ns/division with 5X MAG.

Fig. 12 illustrates the typical procedure for using the delayed sweep feature. However, there are several possible variations to the procedure which are more fully described below.

For close examination of an entire waveform, increase the sweep speed to achieve the desired degree of waveform expansion, then turn the delay time VARIABLE control counterclockwise to examine portions of the waveform nearer the triggering point, and clockwise to examine portions further from the triggering point. If the VARIABLE control reaches its limit of travel, change ranges with the DELAY TIME switch.

If the delay time exceeds the sweep period, none o. the displayed sweep will be intensified when the INTEN button is engaged. Decrease the DELAY TIME setting until part of the trace is intensified.

In the procedure shown in Fig. 12, the channel A and channel B probes are both connected to the same point of measurement. This is generally preferred because it allows one trace to serve as a point of

reference with intensified sweep while the other trace displays the waveform using delayed sweep, such as shown in Fig. 12C. With this arrangement, either the channel A or channel B display can be selected for delayed sweep presentation by the CH A DLY'D or CH B DLY'D buttons. This technique requires alternate triggering dual-trace operation. However, both probes do not have to monitor the same waveform. If two different waveforms are monitored, you may even wish to select CH A DLY'D and CH B DLY'D simultaneously, which is possible.

It is not necessary to use dual-trace operation to use the delayed sweep feature. In CH A or CH B single-trace operation, pressing the INTEN button gives intensified sweep as shown in Fig. 12B, except only one trace is displayed. This facilitates setting the DELAY TIME and VARIABLE controls to the desired area of interest. Pressing the CH A DLY'D button (CH A single-trace operation) or CH B DLY'D button (CH B single-trace operation) provides the delayed sweep display, as typified by the channel B waveform in Fig. 12C.

RISE TIME MEASUREMENTS

Rise time is defined as the period of time required for a pulse to rise from the 10% level to the 90% level of transition. For convenience in making rise time measurements, the 0%, 10%, 90%, and 100% levels are marked on the graticule scale of the CRT. Merely adjust the amplitude and position controls to display the two states of the pulse at the 0% and 100% marks. Expand the waveform to the fastest calibrated sweep speed that will permit the 0% and 100% points to remain within the horizontal limits of the graticule scale. Measure the time interval between the 10% and 90% levels; this is the pulse rise time.

For direct measurement of rise time, the rise time of the oscilloscope should be at least three times as fast as the pulse being measured. The "observed" rise time is actually the cascaded rise times of the pulse being measured and the oscilloscope's own rise time, which are combined in square law addition as follows:

$$\text{observed rise time} = \sqrt{(\text{pulse rise time})^2 + (\text{scope rise time})^2}$$

The effect of the oscilloscope's rise time is almost negligible when its rise time is at least three times faster than that of the pulse being measured, but increases progressively as the pulse rise time approaches that of the scope. With its 11.7 ns rise time on all except the 2 mV sensitivity range, the Model 1530 Oscilloscope may be used for direct measurement of pulse rise time down to about 35 ns (about 55 ns on the 2 mV sensitivity range). For "observed" rise time below 35 ns, the pulse rise time should be calculated to eliminate the error introduced by the cascaded oscilloscope rise time. Calculate pulse rise time as follows:

$$\text{pulse rise time} = \sqrt{(\text{observed rise time})^2 - (\text{scope rise time})^2}$$

"Observed" rise time measurements below 16 ns are not recommended, because a very small reading error introduces significant error into the calculation.

EXTERNAL HORIZONTAL INPUT (X-Y OPERATION)

For some measurements, an *external* horizontal deflection signal is required. This is also referred to as an X-Y measurement, where the Y input provides vertical deflection and the X input provides horizontal deflection.

In conventional sweep operation, the vertical (Y) axis corresponds to voltage, while the horizontal (X) axis corresponds to time. In X-Y operation, both axes correspond to voltage. The vertical (Y) axis corresponds to the voltage applied to the Channel A input, and the horizontal (X) axis corresponds to the voltage applied to the Channel B input.

X-Y operation permits the oscilloscope to perform many types of measurements not possible with conventional sweep operation. The CRT display becomes an electronic graph of two instantaneous voltages. The display may be a direct comparison of the two voltages such as during phase measurement, frequency measurement with Lissajous waveforms, and vectorscope display of video color bar patterns. However, the X-Y mode can be used to graph almost any dynamic characteristics if a transducer is used to change the characteristic (frequency, temperature, velocity, etc., etc., etc.) into a voltage. For example, the horizontal deflection voltage during frequency response measurements is proportional to frequency; thus X axis corresponds to frequency.

The horizontal input must be 2 mV to 5 V per division of deflection; thus any voltage of 20 mV or greater is sufficient for satisfactory operation. With a 10:1 probe, voltage up to 500 V p-p may be used. To use an external horizontal input, use the following procedure:

1. Set the SWEEP TIME/DIV switch fully clockwise to the CH B position.
2. Use the channel A probe for the vertical input and the channel B probe for the horizontal input.

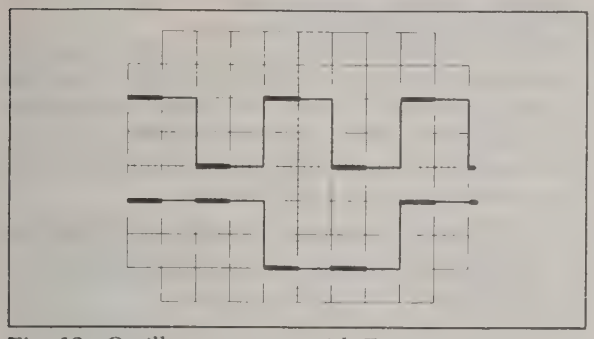

Fig. 13. Oscilloscope trace with Z-axis input.

3. Adjust the amount of horizontal deflection with the CH B VOLTS/DIV and VARIABLE controls.
4. The CH B (vertical) POSITION control now serves as the horizontal position control, and the ◄► POSITION control is disabled.

NOTE

Do not use the PULL 5X MAG control during X-Y operation. Use the CH B VARIABLE and VOLTS/DIV controls to adjust horizontal gain.

5. All sync controls are disconnected and have no effect.

Z-AXIS INPUT

The trace displayed on the screen may be intensity-modulated (Z-axis input) where frequency or time-scale marks are required. A 2-volt peak-to-peak or greater signal applied to the Z-AXIS INPUT jack on the rear of the oscilloscope will provde alternate brightness and blanking of the trace. Positive voltage input increases brightness. See Fig. 13.

SPOT BLANKING

When no signal is applied to the scope in X-Y operation, there is no deflection and the display becomes a stationary spot. This could permanently burn the CRT screen if left at high intensity, such as between set-ups in a series of tests.

In many cases, the spot can be automatically blanked in the absence of signal, or at least reduced in intensity to prevent burning the CRT screen. Conversely, the display is increased in intensity in the presence of signal. This technique uses the intensity modulation feature of the scope, whereby intensity is

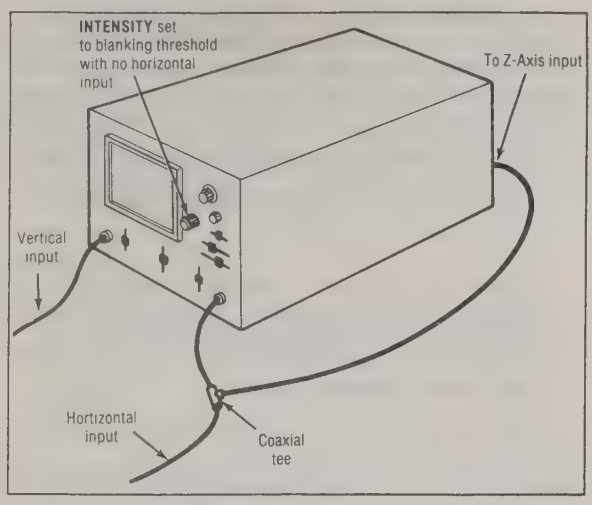

Fig. 14. Connections for spot blanking X-Y operation.

increased when a positive voltage is applied at the Z-AXIS INPUT jack. To use the spot blanking technique, simply tap off the horizontal input signal and apply it to the Z-AXIS INPUT jack too (Fig. 14). With the intensity adjusted just below the blanking level or for a very dim spot *with no signal applied,* any TTL signal or input signal with a positive swing of 2 volts or more should intensify the display to a usable level. Maximum Z-axis input is 50 volts dc + ac peak.

If desired, a spot blanking adapter could be built to provide automatic spot blanking at even lower signal levels, or for signals with a negative voltage swing. Such an adapter would contain a threshold detector (preferably with variable threshold) and a voltage switching transistor. The input to the adapter would be a sample of the horizontal input to the scope, and the output would be a switched voltage to the Z-axis input of the scope. A switched +9 volt output from a transistor battery would work well, or any convenient source of about +5 to +30 volts could be switched.

SINGLE SWEEP

Single sweep operation is valuable for viewing irregular waveforms or instantaneous waveforms such as chattering of contacts when mechanical switches are operated. Such waveforms cannot be viewed clearly when normal repeating sweep is used. This method is also advantageous when photographing such waveforms.

When single sweep operation is enabled, the trace remains blanked until the next trigger signal which ex-

ceeds trigger threshold. Then a single sweep is generated, after which the trace is again blanked. Momentarily setting the SINGLE switch to RESET enables another single sweep. The accompanying READY indicator lights when the single sweep mode is enabled and remains on until the end of the sweep.

The procedure for single sweep operation is as follows:

1. Momentarily set the SINGLE switch to the RESET position. When released, this switch returns to the center (unlabeled) position.
2. The READY indicator lights.
3. The first sync trigger initiates a single sweep.
4. The READY indicator goes off at the end of the sweep.
5. Repeat the procedure for each desired single sweep. Return the SINGLE switch to the NORM position when single sweep operation is completed.

WAVEFORM PHOTOGRAPHS

Waveforms displayed on the CRT may be photographed with an oscilloscope camera. The bezel is slotted to mount a standard oscilloscope camera. The camera should permit double exposure photographs to be taken; that is, the shutter should not be interlocked with the film winder.

1. Adjust oscilloscope controls for a stable, jitter free display of the desired waveform and take a photograph.
2. Next, set the SWEEP TIME/DIV control to about 0.1 mS/division and select automatic sweep with the PULL AUTO position of the trigger LEVEL control.
3. Then hold the SINGLE switch in the RESET position and adjust the INTENSITY control to illuminate the entire CRT screen. This will accentuate the black graticule scale against a light background.
4. Using a double exposure technique, photograph the graticule scale. The result will be a single photograph of the waveform superimposed on the graticule scale.

OPERATOR MAINTENANCE

WARNING

To prevent electric shock, do not perform servicing that requires removal of the covers unless you are qualified to do so. Exposed high voltage, up to 6,000 volts is present when covers are removed. The following procedures do not require removal of the top or bottom cover.

FUSE REPLACEMENT

Fuse F1 is in series with the primary of the power transformer. If this fuse blows, the pilot light will go out and the oscilloscope will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse, then replace only with a fast blow fuse of the proper current rating; 0.6 amp for 120 VAC operation or 0.3 amp for 240 VAC operation. The fuse is located on the rear panel (see Fig. 3).

PERIODIC ADJUSTMENTS

The following operator adjustments only need to be checked and adjusted occasionally. The ASTIG and TRACE ROTATION controls are accessible from the front panel and are adjustable with a flat blade screwdriver. The dc balance adjustments are accessible from the sides of the oscilloscope without removing the bottom case and are adjustable with a very small flat blade screwdriver. The locations of these adjustments are shown in Fig. 3.

Trace Rotation

Strong magnetic fields, present in many locations where an oscilloscope may be used, may cause the trace to be tilted. The degree of tilt may vary as the scope is moved from one location to another. The CRT should be rotated so the trace is parallel with the horizontal lines on the graticule scale.

1. Set oscilloscope controls to produce a horizontal trace with no input signal (PULL AUTO position of triggering LEVEL switch).
2. Use POSITION controls as required to position the trace along a horizontal line of the graticule scale.
3. Adjust TRACE ROTATION so trace is parallel with the reference line on the graticule scale.

Astigmatism

1. Set SWEEP TIME/DIV switch to CH B position and channel A and channel B AC-GND-DC switches to GND position. This will produce a spot on the screen.
2. With INTENSITY control set about mid-range, adjust both the ASTIG and FOCUS controls for the sharpest, roundest spot. Do not readjust ASTIG control after this step.

CAUTION

Never allow a small spot of high brillance to remain stationary on the screen for more than a few seconds. The screen may be permanently burned.

DC Balance

1. Set scope controls for a single horizontal trace on channel A with the channel A AC-GND-DC switch set to GND position.
2. Rotate the Channel A VARIABLE control from maximum clockwise to maximum counterclockwise, while observing the trace.
3. If the trace moves vertically, adjust VR101 (VARI. ATT. BAL.) for minimum or zero movement when performing step. 2.
4. Rotate Channel A VOLTS/CM switch through the 5 mV, 10 mV, and 20 mV positions while observing the trace.
5. If the trace moves vertically, adjust VR103 (STEP ATT. BAL.) for miimum or zero vertical movement when performing step 4.
6. Repeat the entire procedure for Channel B, adjusting VR106 for VARIABLE balance and VR108 for VOLTS/DIV step balance.

Probe Compensation

Probe compensation adjustment matches the probe to the input of the scope. For best results, compensation of both probes should be adjusted initially, then the same probe always used with channel A and channel B respectively. Probe compensation should be readjusted whenever a probe from a different oscilloscope is used, or the channel A and B probes are interchanged.

1. Connect probes to both INPUT jacks. Connect ground clip of probes of oscilloscope ground terminal and touch tips of both probes to CAL 1 kHz ⎍ 0.5 V p-p terminal.
2. Select single trace operation of channel A, then channel B, for steps 3 and 4.
3. Set oscilloscope controls to display 3 or 4 cycles of CAL square wave at 5 or 6 divisions amplitude.
4. Adjust compensation trimmer on probe for optimum square wave waveshape (minimum overshoot, rounding off, and tilt).

CALIBRATION CHECK

A general check of calibration accuracy may be made by displaying the output of the CAL 1 kHz ⎍ 0.5 V p-p terminal on the screen. This test signal has been factory adjusted to provide a square wave of 0.5 volt peak-to-peak amplitude and 1 millisecond time duration per cycle.

At .1 V/div this should produce five divisions of vertical deflection on channel A or channel B, or five divisions of horizontal deflection in X-Y operation when the VARIABLE controls are set to CAL. The 10 mV/div range may be used to check the 10:1 attenuation of the probe; five divisions of deflection should result.

With a .1 ms/div sweep time and VARIABLE set to CAL, one cycle of the waveform should occupy 10 divisions. At 1 ms/div sweep time, 10 cycles should span the 10 divisions, while 2 cycles should cover the 10 divisions using 5X magnification.

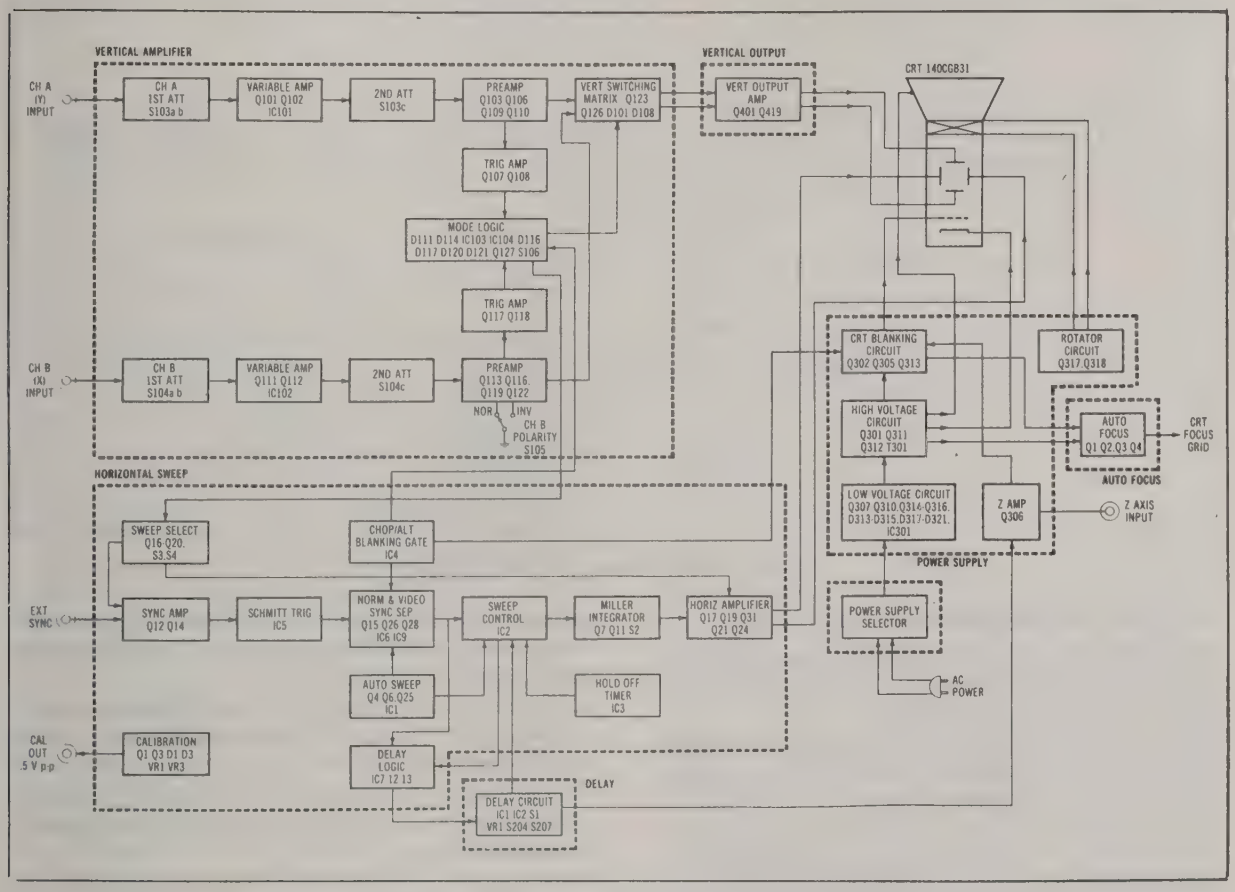
VERTICAL AMPLIFIER
VERTICAL OUTPUT
CRT 140CGB31
CH A (Y) INPUT
CH A 1ST ATT S103a b
VARIABLE AMP Q101 Q102 IC101
2ND ATT S103c
PREAMP Q103 Q106 Q109 Q110
VERT SWITCHING MATRIX Q123 Q126 D101 D108
VERT OUTPUT AMP Q401 Q419
TRIG AMP Q107 Q108
MODE LOGIC D111 D114 IC103 IC104 D116 D117 D120 D121 Q127 S106
TRIG AMP Q117 Q118
CH B (X) INPUT
CH B 1ST ATT S104a b
VARIABLE AMP Q111 Q112 IC102
2ND ATT S104c
PREAMP Q113 Q116 Q119 Q122
NOR INV
CH B POLARITY S105
CRT BLANKING CIRCUIT Q302 Q305 Q313
ROTATOR CIRCUIT Q317 Q318
HIGH VOLTAGE CIRCUIT Q301 Q311 Q312 T301
AUTO FOCUS Q1 Q2 Q3 Q4
CRT FOCUS GRID
AUTO FOCUS
LOW VOLTAGE CIRCUIT Q307 Q310 Q314 Q316 D313 D315 D317 D321 IC301
Z AMP Q306
Z AXIS INPUT
POWER SUPPLY
HORIZONTAL SWEEP
SWEEP SELECT Q16 Q20 S3 S4
CHOP/ALT BLANKING GATE IC4
EXT SYNC
SYNC AMP Q12 Q14
SCHMITT TRIG IC5
NORM & VIDEO SYNC SEP Q15 Q26 Q28 IC6 IC9
SWEEP CONTROL IC2
MILLER INTEGRATOR Q7 Q11 S2
HORIZ AMPLIFIER Q17 Q19 Q31 Q21 Q24
POWER SUPPLY SELECTOR
AC POWER
AUTO SWEEP Q4 Q6 Q25 IC1
HOLD OFF TIMER IC3
CAL OUT .5 V p-p
CALIBRATION Q1 Q3 D1 D3 VR1 VR3
DELAY LOGIC IC7 12 13
DELAY
DELAY CIRCUIT IC1 IC2 S1 VR1 S204 S207

Fig. 15. Block diagram of complete oscilloscope.

GENERAL

Refer to the complete oscilloscope block diagram in Fig. 15. The Model 1530 Dual-Trace Oscilloscope provides identical attenuators and preamplifiers for channel A and channel B inputs. The outputs of the preamplifiers are applied to the vertical amplifier circuit after proper switching.

Selection of channel A or channel B signals for vertical deflection is accomplished by the vertical switching matrix. The mode switch and vertical mode logic circuit gates only the channel A signal in CH A mode and X-Y operation, only the channel B signal in CH B mode alternately gates each in the DUAL mode, or simultaneously gates both in the ADD mode. The vertical input signal is then fed to the vertical output circuit and applied to the vertical deflection plates of the CRT.

The horizontal sweep circuit generates a sawtooth waveform synchronized by triggering signals from the vertical circuit or from an external source. The sawtooth waveforms drive the horizontal amplifier and are applied to the horizontal deflection plates of the CRT. During X-Y operation, the channel B vertical input signal is amplified and applied as a horizontal signal to the horizontal amplifier.

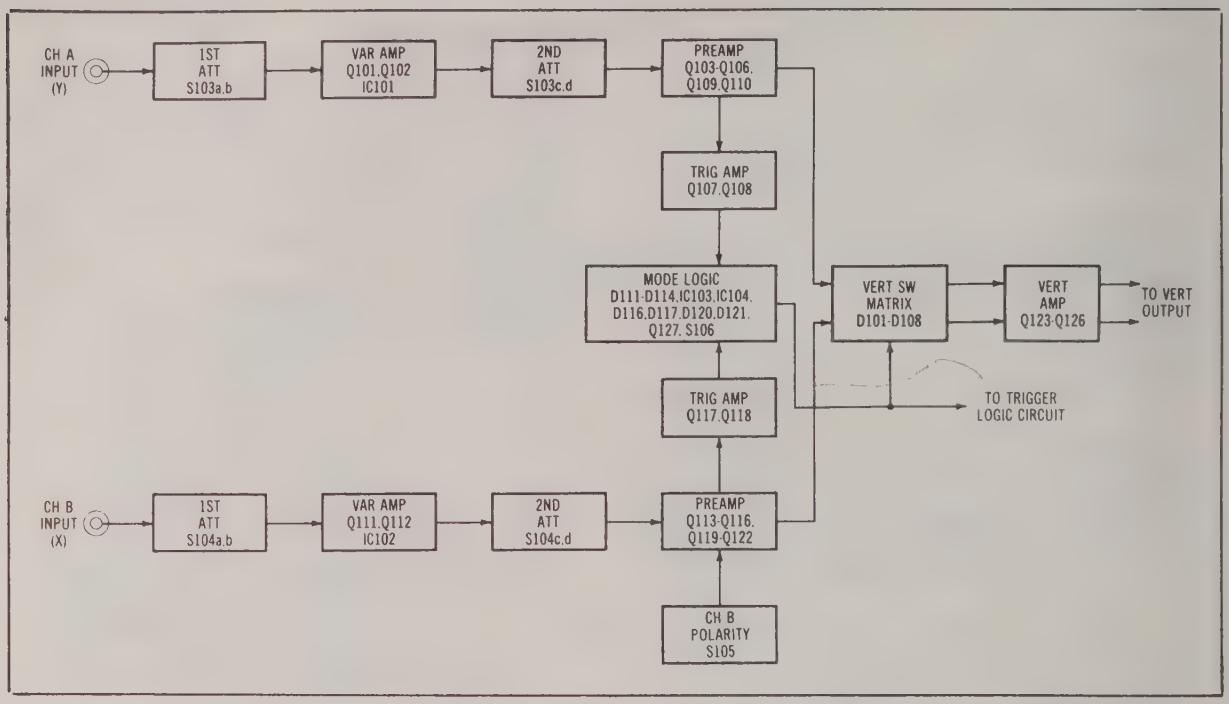

Fig. 16. Block diagram, vertical preamp.

VERTICAL AMPLIFIER (Refer to Fig. 16)

Channel A (Y) and channel B (X) preamplifiers are identical circuits and operate the same. Only channel A is described in the following description.

The vertical input signal from the input terminal is coupled to the first attenuator section directly or capacitively, as selected by the AC-GND-DC switch, S101. One section of the VOLTS/DIV switch, S103, provides ratios of 1:1, 10:1, 100:1, and 1000:1. After the first attenuator section, the signal is fed to a high impedance input stage of the vertical preamp consisting of a dual FET, Q102. The balanced configuration of this circuit provides excellent dc balance stability against temperature change and power supply voltage fluctuations. Transistor Q101 and diode D122 protects Q102 from negative overvoltage. Positive overvoltage is clamped by Q102 itself.

The outputs of Q102 are applied to an op-amp, IC101, whose output is fed to a second attenuator circuit controlled by the second section of the VOLTS/DIV switch, S103. The second attenuator provides ratios of 1:1, 2:1, and 5:1. Together, the first and second attenuator sections give an attenuation sequence of 1-2-5, with the appropriate exponent.

Transistors Q103-Q106, Q109, and Q110 further amplify the vertical signal before it reaches the vertical drive amplifiers, Q123-Q126. A sample of the vertical signal at the collectors of Q105 and Q106 is amplified by trigger amplifiers Q107 and Q108, and applied to the triggering circuits through the mode logic circuits.

The only difference between channel A and channel B preamplifiers is that CH B POLARITY switch, S105, reverses the polarity of the channel B signal when in the INV position. This is accomplished by switching on either transistor pair Q119/Q122 or Q120/Q121 in the channel B preamplifier circuit.

MODE LOGIC (Refer to Fig. 17)

The mode of operation, CH A, CH B, DUAL, ADD is selected by the MODE switch, S106, and controlled by digital logic circuits IC103, IC104, and diodes D101-D108. When CH A mode is selected, a low is placed at the set (S) input of IC104. The Q output is high and $\overline{Q}$ output is low at this time. This reverse biases D101 and D104 which are connected to the collectors of the CH A vertical preamplifiers. This allows the CH A vertical signal to be applied to vertical drive amplifiers Q123-Q126. Diodes D107 and D108 are forward biased by the low on the $\overline{Q}$ output of IC104, preventing the CH B signal from reaching vertical drive amplifiers Q123-Q126.

In the CH B mode, the reverse action occurs by applying a low to the reset (R) input of IC104. This causes the Q output of IC104 to go low and the $\overline{Q}$ output to go high, al-

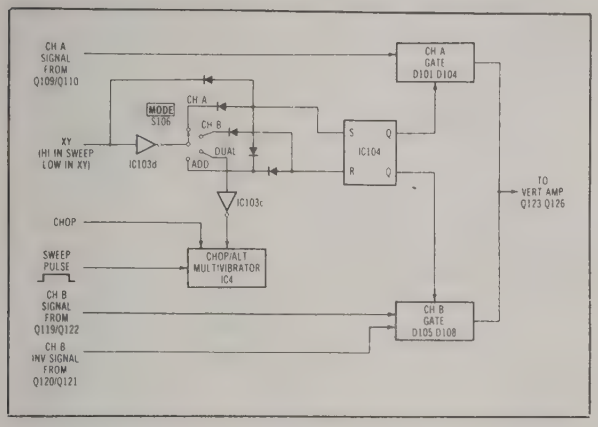

Fig. 17. Simplified circuit diagram, vertical mode logic.

lowing the CH B vertical signal to be applied to vertical drive amplifiers Q123-Q126.

When the MODE selector is in the DUAL position, both channels are displayed. Below a sweep speed of 0.5 ms/division, or when the CHOP button is engaged, IC104 outputs are switched by a 200 kHz clock pulse (CP) applied to the clock input (CP) of IC104. In this state, the Q and $\overline{Q}$ outputs of IC104 change with each CP input. This action chops the trace into 5μs segments which are alternately switched between CH A and CH B to provide a dual trace. The clock pulse is generated by an oscillator on the sweep board and coupled to IC104.

For sweep speeds of 0.5 ms/division or faster, or when ALT triggering is selected, the Q and $\overline{Q}$ outputs of IC104 switch states after every sweep; therefore, CH A and CH B vertical signals alternate for display. Thus, CH A is viewed during one sweep and CH B is viewed during the next.

When the ADD mode is selected, both the set (S) and reset (R) inputs of IC104 are low and the Q and $\overline{Q}$ outputs are both high. The signals from both CH A and CH B are added algebraically and applied to vertical drive amplifiers Q123-Q126 via diodes D101, D102 (CH A) and D105, D106 (CH B).

VERTICAL OUTPUT AMPLIFIER (Refer to Fig. 18)

The output signal from vertical drive amplifiers Q125 and Q126 is applied to the vertical output amplifiers consisting of two stages of differential amplifiers Q401-Q404. These connect to two emitter followers, Q405 and Q406, which drive cascode amplifiers, Q408-Q411. The output of the cascode amplifiers is applied to the deflection plates of the CRT.

Negative feedback from the cascode amplifiers is applied to the base of Q405 and Q406, via FET inverters, Q414 and Q415. Four transistors, Q412, Q418, Q413, and Q419, provide current sources for cascode amplifiers

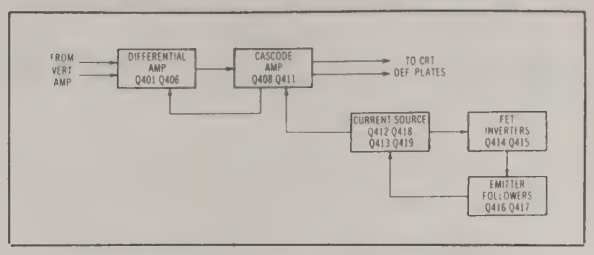
FROM VERT AMP
DIFFERENTIAL AMP Q401 Q406
CASCODE AMP Q408 Q411
TO CRT DEF PLATES
CURRENT SOURCE Q412 Q418 Q413 Q419
FET INVERTERS Q414 Q415
EMITTER FOLLOWERS Q416 Q417

Fig. 18. Block diagram, vertical output amplifier.

Q408-Q411. Emitter followers Q416 and Q417 drive current source transistors Q418 and Q419 when extra current is required for fast signals.

TRIGGER CIRCUIT (Refer to Fig. 19)

The CH A vertical signal at the emitters of Q105 and Q106 is amplified by trigger amplifiers, Q107 and Q108, and applied to Q127. The output of Q127 is used as a trigger source. The CH B signal from Q115 and Q116 is amplified by trigger amplifiers, Q117 and Q118, and also applied to Q127. Digital logic circuits IC8, IC103, and diodes D120 and D121 determine which signal shall be selected as the trigger source.

Trigger selection is primarily dependent upon the position of the SOURCE switch, S3. When the SOURCE switch is in the CH A position, the channel A signal becomes the trigger signal, regardless of the mode of operation. Likewise, when the SOURCE switch is in the CH B position, the channel B signal is always the trigger signal. In the EXT position, the signal applied at the EXT TRIG jack is the trigger signal. In the LINE position, a 50 or 60 Hz power line signal from the 14-volt secondary of the power transformer becomes the trigger signal. When the SOURCE switch is in the ALT position, trigger selection is secondarily dependent upon the position of MODE switch S106, and allows the trigger source to automatically follow the operating mode. With the SOURCE switch in ALT and the MODE switch in CH A or ADD modes, the channel A signal becomes the trigger signal; and when the SOURCE switch is in ALT and the MODE switch is in CH B, the channel B signal becomes the trigger. If the SOURCE switch is in ALT while the MODE switch is in DUAL, the channel A and channel B signals are alternately selected as triggers at the end of each sweep.

Whenever the channel A signal is to be the trigger signal, diode D120 is reverse biased and permits channel A trigger signal from Q108 to reach transistor Q127. Conversely, when D120 is forward biased, the channel A trigger signal is shunted to ground and does not reach Q127. Similarly, diode D121 permits the channel B trigger signal from Q118 to reach Q127 when reverse biased, or shunts the Q118 output to ground when forward biased.

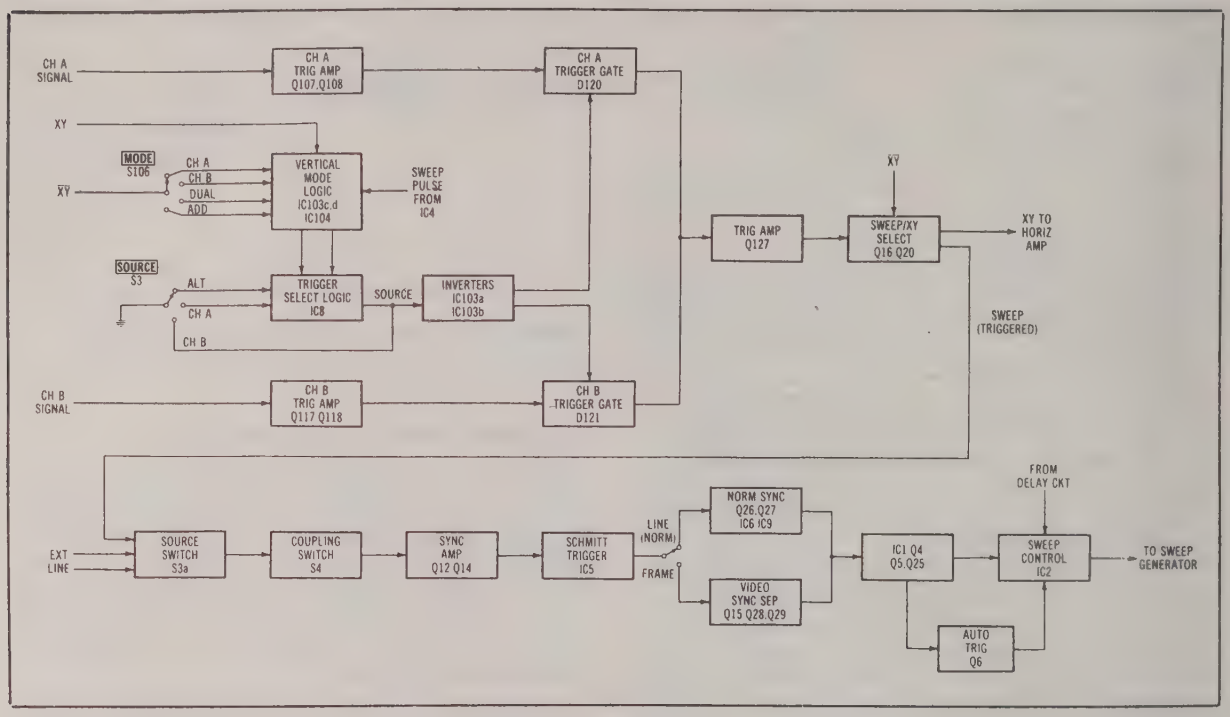

Fig. 19. Block diagram, trigger circuit.

Selection of the channel A or B trigger signal is controlled by IC103a and IC103b in response to the "Source" signal from IC8. When the "Source" signal is high, the output of IC103b is low and D121 is forward biased to shunt the channel B signal; simultaneously, the output of IC103a is high and D120 is reverse biased and the channel A signal is allowed to reach Q127. The reverse action is also true.

When SOURCE switch S3 is in the CH B position, a ground is placed directly on the "Source" line. With S3 in the CH A position, IC8 latches the "Source" line high. When S3 is in the ALT position, IC8 is toggled by IC103 at the end of each sweep, causing the "Source" line to alternately go low and high. IC 103, in turn, is toggled by the CP (clock pulse) input from the chop/alternate multivibrator, IC4, of the vertical mode logic circuit. A line from S3 to IC4 locks out chop operation when S3 is in the ALT position.

In X-Y operation, the $\overline{XY}$ signal is low. This low is applied through diode D119 to IC104, which selects the channel A signal for vertical deflection. The $\overline{XY}$ signal is also applied to IC103 which selects the channel B trigger signal via Q127 for horizontal deflection.

In normal sweep operation, the selected trigger signal output of Q127 is routed through amplifiers Q20 and Q16 on the sweep board. In X-Y operation, amplifier Q19 is enabled and the channel B trigger signal is applied via Q19 and Q31 to the horizontal output amplifiers.

The triggering signal is then routed to the FET amplifier, Q12, through the COUPLING switch, S4. The signal is direct coupled in the DC position, and capacitively coupled in the AC position. The signal is capacitively coupled through a low-pass filter in the HF REJ position and a high-pass filter in the LF REJ position.

When the FIX-NORM pushbutton switch, S203, in the NORM position (button released), the output of Q12 is directly coupled to emitter follower, Q13, which drives one input (pin 2) of Schmitt trigger IC5. The TRIG LEVEL control, VR8, sets a DC reference level at the other input (pin 1) of IC5 through Q14. IC5 acts as a high-gain differential amplifier, or Schmitt trigger. When the signal on pin 2 exceeds the dc level on pin 1, the output of IC5 changes state and results in a sharp trigger. When the pin 2 level drops below the pin 1 level, a trigger signal of the opposite polarity is developed.

When the FIX-NORM switch, S203, is in the FIX position, the output of Q12 is capacitively coupled to Q13 and then to pin 2 of IC5. The dc reference voltage for pin 1 is developed by detecting and filtering the trigger input voltage at the input of Q14. This is used instead of the dc reference level from the TRIG LEVEL control, and establishes a threshold level for IC5 at the center of the waveform being used for triggering.

The positive and negative output signals of IC5 are applied to the normal sync gates of IC6 and IC9, through Q26 and Q27. When the SLOPE switch, S5, is in the positive (+) position, the Q26 signal is gated through IC6 and IC9. When the SLOPE switch, S5, is in the negative (−) position, the Q27 signal is gated through IC6 and IC9.

When the NORM-SINGLE-RESET switch, S209, is in the SINGLE position, the input (pin 2) of IC3 goes high. In this condition, a clock pulse input must be applied to IC3 to cause its output (pin 3) to go high and enable the sweep control multivibrator, IC2. This is accomplished by placing the NORM-SINGLE-RESET switch, S209, in the RESET position which enables IC2 for one sweep only. The hold-off pulse at the end of the single sweep reverts IC3 to the standby condition (IC3 goes low), which remains in that state until switch S209 is again placed in the RESET position. The output of IC3 (pin 3) drives the READY LED which lights when S209 is in the RESET position, and stays on until the sweep is completed.

When the FRAME-LINE pushbutton switch, S204, is in the FRAME position (button depressed) it inhibits IC9 and allows the video sync circuits, Q15, Q28, and Q29, to supply the sweep triggering signal. The polarity of the signal from IC5 is selected by the SLOPE switch, S5, and applied to Q15, Q28, and Q29. Capacitor C65, in the coupling circuit between Q28 and Q29, shunts the short duration horizontal sync pulses and allows the longer duration vertical sync pulses to reach Q29. This action separates horizontal and vertical sync pulses to allow viewing of vertical frames of fields of video.

The trigger pulse at the output of IC9 is connected to the K input of sweep control multivibrator IC2 through IC1, Q4, Q5, and Q25. This signal synchronizes the sweep to the waveform being used as the trigger source. In the absence of triggering, no sweep is normally developed; however, pulling out the PULL AUTO switch enables Q6, and multivibrator IC2 will run freely providing horizontal sweep.

HORIZONTAL SWEEP (Refer to Fig. 20)

Horizontal deflection is produced by the horizontal preamplifiers and horizontal output amplifiers. In all except X-Y operation, the input to the horizontal preamplifiers is furnished by the calibrated sweep speed circuits consisting of the sweep control circuit (IC2), Miller integrator Q10 and Q11, and hold-off timer, IC3. The sweep can be synchronized by the CH A or CH B input signal, or by an external trigger signal. In the absence of a synchronizing trigger signal, the automatic sweep circuit, Q4, Q5, Q6, Q25, and IC1, can start the sweep. When X-Y operation is selected, the CH B signal is coupled to the horizontal amplifiers for horizontal deflection and the sweep circuits are disabled.

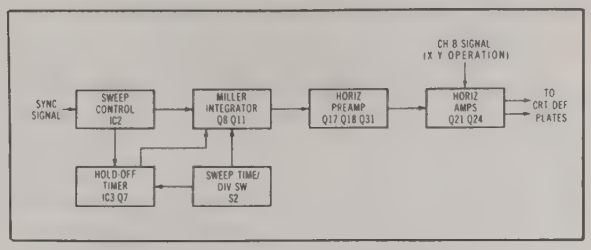

Fig. 20. Block diagram, horizontal sweep.

When a trigger pulse appears at the reset (R) input of IC2, the Q output goes low allowing the sweep ramp integrator circuit, Q10 and Q11, to begin sweep. Sweep speed is determined by the RC time constants set by the SWEEP TIME/DIV switch, S2. The output of the integrator, a decreasing linear ramp, is fed through transistors Q8 and Q9 to the horizontal amplifier stages, Q17-Q24, and Q31. The outputs of Q23 and Q24 are connected to the horizontal deflection plates of the CRT.

An increasing linear ramp signal from the integrator circuit is fed to the threshold input of sweep hold-off timer, pin 6 of IC3. When the decreasing ramp voltage has swept the scope trace to the right hand limit of the sweep cycle, the corresponding increasing ramp voltage is fed to pin 6 of IC3. This causes pin 3 of IC3 and the set (S) input of IC2 to go low, setting the Q output of IC2 to high and turning on transistor Q7. This discharges the integrating capacitor and resets the sweep back to the left-hand sweep limit. At the same time as the Q output of IC2 goes high, the $\overline{Q}$ output goes low and sends a high out the blanking control gate, pin 11 of IC4. This turns the trace intensity down so you cannot see the retrace as the electron beam is returned to the left-hand side of the CRT.

At the time the threshold setting of IC3 was reached, pin 3 low, the sweep hold-off capacitor connected to pin 2 of IC3 discharges through the HOLD OFF control, VR207. When the capacitor has discharged to less than 1.6 volts, pin 3 of IC3 is triggered high. This readies IC2 for the next trigger pulse, coming from either the clock input (pin 12) or from the reset (R) input when Q25 of the automatic triggering circuit is turned on. Pin 7 of IC3 also goes high and allows the hold-off capacitor to charge up again. The length of sweep hold-off is determined by the capacitor and the optimum value for each sweep speed automatically selected by the SWEEP TIME/DIV control.

During X-Y operation, the SWEEP TIME/DIV switch is set to CH B. The $\overline{XY}$ signal is then applied to disable sweep amplifiers Q18 and Q17 and enable XY amplifier Q19. The CH B trigger amplifier output is fed to the horizontal amplifiers via Q19 and Q31. In this mode, the CH B signal controls the horizontal position of the CRT trace.

DELAYED TRIGGERING (Refer to Fig. 21)

The purpose of the delay circuit is to allow a variable delay period to be inserted between the occurence of the trigger and the beginning of the sweep. The delay may be individually inserted before the channel A sweep or channel B sweep, if desired, with the CH A DLY'D and CH B DLY'D pushbutton switches. With neither delay selected, normal non-delayed triggering is available. The non-calibrated delay period can be displayed on the CRT and quite accurately adjusted by using the intensify feature. Pressing the INTEN switch causes the delay period to be displayed at normal intensity, and the balance of the trace to be intensified (brighter).

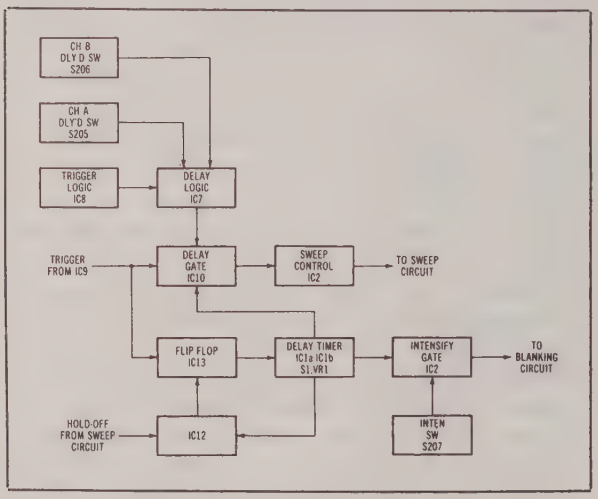

Fig. 21. Block diagram, delay circuit.

In normal non-delayed operation, delay gate IC10 is enabled so that the trigger from IC9 is coupled to sweep control IC2 without delay. When CH A DLY'D switch S205 is pressed, delay logic IC7 sets up IC10 so that the delay period occurs before the channel A trigger is coupled to IC2. Similarly, when CH B DLY'D switch S206 is pressed, IC7 sets up IC10 so that the delay period occurs before the channel B trigger is coupled to IC10. Inputs to IC7 from IC8 synchronize the delay to channel A or channel B.

The trigger that is applied to IC10 is simultaneously applied to flip-flop IC13. Flip-flop IC13 is enabled by IC12 at the end of hold-off period. The trigger causes IC13 to change states and start the delay timer. The delay timer consists of IC1a and IC1b, RC time constant components C1-C6, R5, R6, DELAY TIME switch S1, and VARIABLE control VR1. At the end of the delay period, IC1a changes states, which causes IC10 to trigger IC2. During hold-off, feedback to IC12 keeps IC13 disabled and the delay timer is reset.

The delay pulse from IC1a is also applied to intensify gate IC2. When selected by INTEN switch S207, an output pulse from IC2 (which begins at the end of the delay period) is applied to the blanking circuits. This pulse is superimposed on the blanking pulse as intensity modulation; the delay period is of normal intensity, and the balance of the trace is intensified. The end of sweep (beginning of hold-off) also ends the intensify pulse via IC12 and IC13.

HIGH VOLTAGE POWER SUPPLY (Refer to Fig. 22)

The unregulated +15 volt power supply drives a dc-to-dc converter circuit consisting of Q301, Q311, Q312, and T301. Transformer and transistor Q301 form an oscillator which operates at approximately 20 kHz. A high voltage 20 kHz ac is thus developed across the secondary of T301. The secondary voltage of transformer T301 is rectified by D301 and filtered as −1.5 kV for the cathode of the CRT. Regulation is achieved by feedback of the −1.5 kV across a voltage divider to Q311 and Q312. VR 303 adjusts the high voltage. The −1.5 kV is also applied across the FOCUS control, VR205, to the focus grid of the CRT. A tapped portion of the high voltage secondary of T301 is applied through Q302 to blanking rectifier D304 and D305. This circuit is referenced to −1.5 kV, but develops additional negative dc voltage for the control grid to keep the CRT blanked during retrace. A pulse from the blanking circuit is superimposed in the Q102 circuit to unblank the CRT during sweep.The secondary voltage of T301 is also applied to rectifier/voltage tripler D301, which provides +4.5 kV to the anode of the CRT. Filament voltage for the CRT is provided by a separate low-voltage secondary of T301, which is floated at cathode potential.

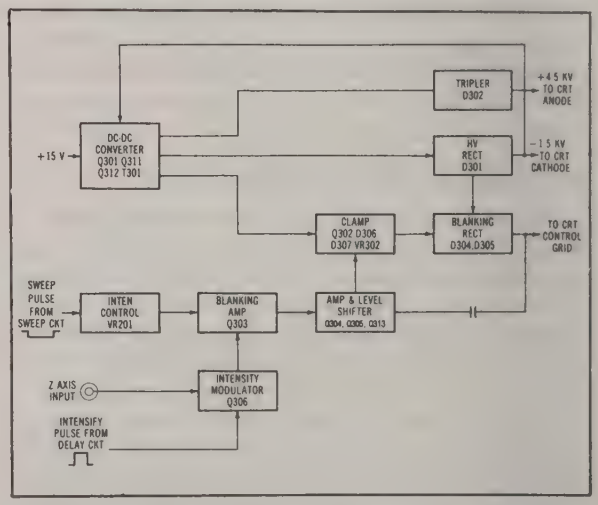
TRIPLER D302
+4.5 KV TO CRT ANODE
+15 V
DC-DC CONVERTER Q301 Q311 Q312 T301
HV RECT D301
−1.5 KV TO CRT CATHODE
CLAMP Q302 D306 D307 VR302
BLANKING RECT D304,D305
TO CRT CONTROL GRID
SWEEP PULSE FROM SWEEP CKT
INTEN CONTROL VR201
BLANKING AMP Q303
AMP & LEVEL SHIFTER Q304, Q305, Q313
Z AXIS INPUT
INTENSITY MODULATOR Q306
INTENSIFY PULSE FROM DELAY CKT

Fig. 22. Block diagram, blanking, intensity, and high voltage power supply circuits.

BLANKING AND INTENSITY (Refer to Fig. 22)

This circuit blanks the CRT during the retrace period (when electron beam returns from right side to left side of CRT) and unblanks the CRT during sweep. This is accomplished by setting the instantaneous dc voltage on the control grid (pin 3) of the CRT.

A sweep pulse, coincident with the sweep sawtooth waveform, is generated by IC4 and applied to INTENSITY control VR201. The INTENSITY control varies the amplitude of the pulse (now known as the blanking pulse) to blanking amplifier Q303. Subsequent stages Q304, Q305, and Q313 amplify the blanking pulse and shift it to the correct dc level for controlling Q302. During the retrace period, Q302 delivers a higher amplitude switching voltage to blanking rectifiers D304/D305; and the resulting negative dc voltage cuts off the electron beam in the CRT. During the sweep pulse, Q302 limits the amplitude of the switching voltage that reaches D304/D305; the output voltage is less negative, and the electron beam is turned on. The blanking pulse is also capacitively coupled to the CRT control grid for improved response at higher speed speeds.

An external signal at the Z AXIS INPUT jack is applied to intensity modulator Q306, which superimposes the external signal on the blanking pulse in Q303. Similarly, when intensified delay is selected, the "intensify" pulse from the delay circuit is superimposed on the blanking pulse via Q306 and Q303. A positive Z axis input or intensify pulse intensity modulates the electron beam, causing it to be brighter.

CALIBRATING VOLTAGE

Multivibrator circuit Q2 and Q3 on the sweep board generate a 1 kHz square wave. Variable resistors VR2 and VR3 are used to adjust the frequency (pulse width) of the positive and negative portions, respectively. The output is developed across amplifier Q1. Variable resistor VR1 adjusts the output level to 0.5 volts peak-to-peak.

LOW VOLTAGE POWER SUPPLY (Refer to Fig. 23)

The power supply voltages are fully regulated. The −8 volt output is adjusted by VR304. This voltage is used as reference in all the regulators; thus, all the other low voltages are also adjusted.

+15 Volt Supply

The 14-volt secondary winding of power transformer T1 is rectified in the positive polarity by diode bridge D319 to provide an unregulated +15 volts. This is also the source for the +10 volt, +5 volt, and high-voltage supplies.

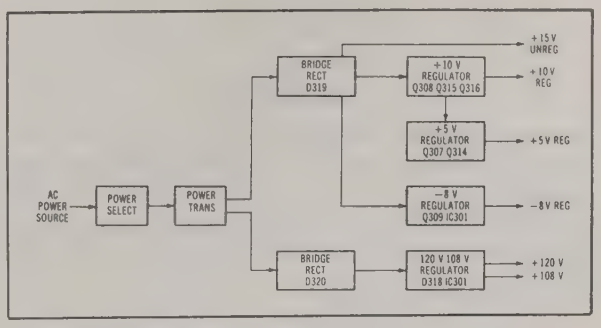

Fig. 23. Block diagram, low voltage power supply.

+10 Volt Supply

The +15 volt supply is regulated to +10 volts by Q308, Q315, and Q316.

+5 Volt Supply

The regulated +10-volt output is regulated to +5 volts by Q307 and Q314.

−8-Volt Supply

The 14-volt winding of power transformer T1 is rectified in the negative polarity by diode bridge D319 and regulated to −8 volts by IC301a and Q309.

+120 Volt and +108 Volt Supply

The 120-volt secondary of power transformer T1 is rectified by diode bridge D320 and regulated by IC301b and Q310 to +120 volts dc. Zener diode D318 drops part of the power supply output to a regulated +108 volts dc.

AUTO FOCUS CIRCUIT

The intensity modulation signal is inverted by transistors Q1, Q2, and Q3. This varies the amplitude of the oscillator circuit of Q4. The oscillator signal is then rectified. The rectified dc voltage is set by the FOCUS control, VR205, and applied to the CRT focus grid. This arrangement automatically refocuses the electron beam when the INTENSITY control is varied by applying a compensating voltage.

SERVICING

WARNING

A high voltage of 6000 VDC is present on the CRT and power supply board when the oscilloscope is operating. Before removing the case, disconnect the ac power from the oscilloscope. Do not touch these parts with the hand or a screwdriver, even after the case has been removed.

PERFORMANCE TESTS

1. Connect the 1530 oscilloscope to the proper power source. Test channel A and channel B independently.
2. Turn the power on by turning the INTENSITY control clockwise. The POWER light should come on.
3. Set the SWEEP TIME/DIV switch to the CH B position (X-Y operation). Adjust the INTENSITY control until a spot appears on the screen. Adjust the vertical and horizontal POSITION controls if necessary.
4. Adjust the INTENSITY and FOCUS controls for a thin, sharp dot.
5. Set the SWEEP TIME/DIV switch to the .1 ms position.
6. Set the CH A and CH B AC-GND-DC switch to the GND position, and the NORM-SINGLE-RESET switch to the NORM position.
7. Select automatic sweep by pulling outward on the triggering LEVEL control (PULL AUTO). A single trace should appear on the screen. If no trace appears, increase the INTENSITY control until a trace is easily observed.
8. Set the MODE switch to the DUAL position. Two traces should appear. Adjust the POSITION controls, if necessary, to position the traces for convenient viewing. The channel A trace should be above the channel B trace with both traces starting at the left edge of the graticule scale.
9. Check for proper adjustments of the TRACE ROTATION, ASTIG, and DC BALANCE controls as outlined under "PERIODIC ADJUSTMENTS".
10. Set the CH A AC-GND-DC switch to the AC position. Place the VOLTS/DIV switch to the .1V position and the VARIABLE control to the CAL position (fully clockwise). Check channel A and channel B independently. Apply the 1 kHz, 0.5 V p-p CAL signal from the front panel to the vertical input terminal. Vertical deflection should cover five divisions, or five divisions of horizontal deflection in the X-Y mode of operation.
11. Set the SWEEP TIME/DIV switch to the .1 ms position, and the VARIABLE control to the CAL position. One cycle of the waveform should cover 10 divisions.
12. Apply a 30 MHz signal from a signal generator to CH A input terminal. Set the SOURCE switch to the CH A position. Set the SWEEP TIME/DIV switch to the fastest sweep speed (0.2 μs/division). Adjust the triggering LEVEL control for a synchronized display without jitter. Repeat this procedure for channel B.
13. Connect a synchronized waveform to the vertical input terminal as in Step 12. Depress the INTEN pushbutton. The first portion of the trace is of normal intensity. The delayed portion of the sweep will be brighter. The beginning of the brighter portion identifies the starting point of the delayed sweep. The delay time period is variable with the DELAY TIME controls.
14. Depress the CH A DLY'D pushbutton. The beginning of the channel A trace is delayed by the period selected by the DELAY TIME controls. When the CH B DLY'D pushbutton is depressed, the beginning of the channel B trace is similarly delayed.
15. Apply a very slow rate pulse (changes state each 5 seconds) to the vertical input terminals of channel A and channel B independently. Momentarily set the NORM-SINGLE-RESET switch to the RESET position. When released it will return to the center position. The READY indicator will light and the first trigger pulse initiates a single sweep. At the end of the sweep, the READY light will go off. Another single sweep will not be generated until the NORM-SINGLE-RESET switch is placed in the RESET position.
16. This concludes the Performance Tests, and the oscilloscope is now ready for waveform observation.

REMOVING THE CASE (Refer to Fig. 24)

1. Remove seven Phillips head screws from both sides and the top of the case.
2. Grasp the handle and lift the top of the case from the cabinet.
3. Remove four Phillips head screws from bottom of case and remove bottom cover from cabinet.

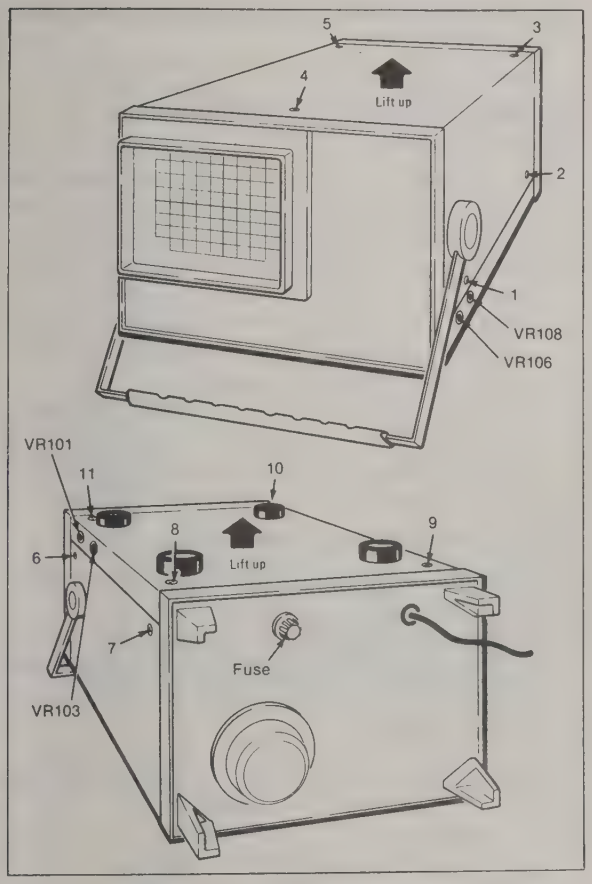

Fig. 24. Removing the case.

4. To replace the top and bottom sections, reverse the foregoing procedure.

120/240 VAC CONVERSION (Refer to Fig. 25)

The Model 1530 normally operates on 120 VAC, 50/60 Hz power. It may also be operated on 240 VAC (210 to 260 VAC), 50/60 Hz power by simply inverting the power selector plug, P5, as follows:

1. Make sure power is disconnected from the oscilloscope. Remove top of case as outlined previously.
2. Remove voltage selector plug, P5, located on the inside of the chassis wall just below the power transformer as shown in Fig. 25.
3. Rotate the plug P5 180° and reinsert it.
4. Replace the 0.7 amp primary line fuse used for 120 VAC operation with a 0.5 amp fuse for 240 VAC operation. The fuse is located on the rear panel of the oscilloscope.
5. Apply the AC 220-240 V, 50/60 Hz label on the rear panel directly over the AC 110-120 V, 50/60 Hz label

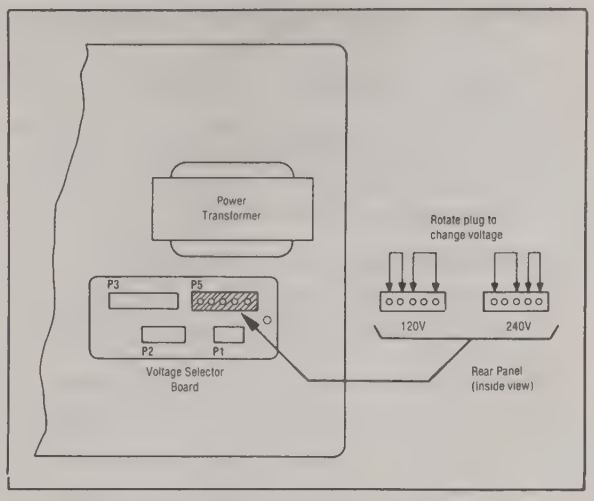

Fig. 25. Conversion from 120 VAC to 240 VAC.

adjacent to the power cord entrance. The power transformer can also be wired for operation from a nominal 100 VAC or 220 VAC, 50/60 Hz power source. This can be done by removing the wire from pin 1 of P3 and connecting it to pin 2 of P3, and removing the wire from pin 4 of P3 and connecting it to pin 5 of P3. Connector P3 is located adjacent to selector plug P5. Use the 0.7 amp fuse for 100 VAC operation, and the 0.5 amp fuse for 220 VAC operation.

CALIBRATION ADJUSTMENTS

The following calibration adjustments can be performed with a minimum of specialized equipment. Additional internal adjustments should be made by an instrument technician with proper calibrating instruments. For location of adjustments, refer to Figs. 26, 27, and 28. Use a well-insulated, flat-bladed screwdriver or a flat-bladed alignment tool while making adjustments. Allow 30 minutes warm-up time before attempting the following adjustments.

Test Equipment Required

Pulse Generator, better than 1% timing accuracy.
DC Voltmeter, 0.5% accuracy or better.
High Voltage Probe, 100 megohms impedance or higher.

Power Supply and CRT Circuit Adjustments

The power supply adjustments are located on the bottom side of the oscilloscope. Refer to Fig. 26.

1. Connect a dc voltmeter to pin 8 of P306, with respect to chassis.
2. Adjust VR304 to obtain $+108.5$ V $\pm 1\%$.
3. Measure the voltages at pins 5, 4, 3, and 2 of P306. The

voltages should be +10 V at pin 5, +15 V at pin 4, +5 V at pin 3, and −8 V at pin 2.

4. Connect a dc voltmeter to pin 8 of P307. The voltage should be +124 V.
5. Connect a high impedance (100 megohms or better) dc voltmeter to pin 9 of P301, with respect to chassis. Use extreme caution.
6. Adjust VR303 to obtain −1.5 kV.

Blanking Adjustment (Refer to Fig. 26)

1. Set SWEEP TIME /DIV switch to the 0.2 μs position and the PULL AUTO switch to the AUTO position to display a trace.
2. Adjust TC301 until the start point of the trace is the same thickness as the remainder of the trace line.

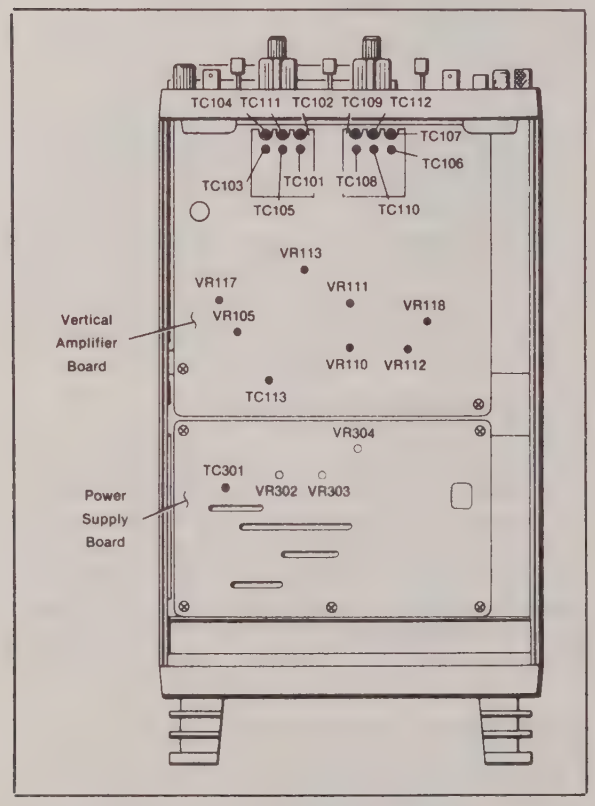

Fig. 26. Locations of adjustments, vertical amplifier and power supply boards.

2 mV Center Adjustment (Refer to Fig. 26)

1. Set CH A AC-GND-DC switch to the GND position, and the SWEEP TIME/DIV switch to the 1 ms position.
2. Adjust VR114 so that trace does not shift when the CH A VOLT/DIV switch is switched between the 2 mV and 5 mV position.
3. Repeat Steps 1 and 2 for CH B, and adjust VR115.

CH B Invert Polarity and Vertical Position Adjustments (Refer to Fig. 26)

1. Set CH A and CH B AC-GND-DC switches to the GND position, the MODE switch to the DUAL position, and the SWEEP TIME/DIV switch to the 1 ms position. Set the PULL AUTO switch to the AUTO position.
2. Adjust VR112 to make sure that channel B trace does not shift when the CH B polarity pushbutton switch is in the INV position (switch depressed).
3. Set the CH A and CH B vertical POSITION controls to the center of their rotation.
4. Adjust VR105 and VR402 (see Fig. 27) so that the traces are superimposed at the center of the screen.

Vertical Gain Adjustment (Refer to Fig. 27)

1. Connect the 1 kHz CAL signal at the front panel jack to the CH A input.
2. Place the VOLT/DIV switch in the .1 V/cm position and the VARIABLE control fully clockwise to the CAL position. A square wave 5 cm ±2 mm high should be observed.

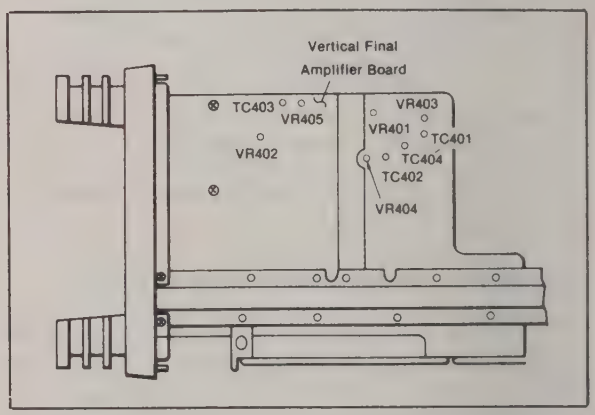

Fig. 27. Location of adjustments, vertical output board.

3. If the square wave is less or greater than 5 cm ±2 mm, adjust VR401 for 5 cm.
4. Connect the 1 kHz CAL signal to the CH B input.
5. Place the CH B VOLTS/DIV switch to the .1 V/cm position and the VARIABLE control fully clockwise to the CAL position. A square wave 5 cm ±2 mm high should be observed.
6. If the square wave is less or greater than 5 cm ±2 mm, adjust VR110 (Fig. 26), for 5 cm.

Horizontal Sweep Timing Adjustment (Refer to Fig. 28)

1. Place the SWEEP TIME/DIV switch in the 1 ms position, and the horizontal POSITION control at the center of its rotation.
2. Connect pulse generator to the CH A input and apply a 1 ms marker signal and adjust for 10 pulses, 1 ms apart.
3. Adjust VR15 so that a pulse appears on each division of the graticule scale on the screen.

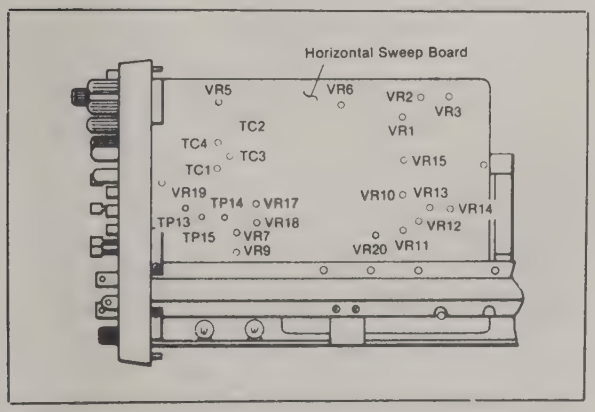

Fig. 28. Location of adjustments, horizontal sweep board.

4. Adjust VR6 so that sweep length slightly exceeds 10 divisions (approximately 10.5 divisions).

Horizontal Position Adjustments (Refer to Fig. 28)

1. Apply a 5 ms marker signal from the pulse generator to the CH A input. Set SWEEP TIME/DIV switch to the 1 ms position. Set the horizontal POSITION control to the center of its rotation. Three pulses should be displayed.
2. Adjust VR10 until the center of the three pulses corresponds to the Y axis on the graticule scale.

INSTRUMENT REPAIR SERVICE

Because of the specialized skills and test equipment required for instrument repair and calibration, many customers prefer to rely upon B & K-Precision for this service, if it is ever needed. We maintain a network of B & K-Precision authorized service agencies for this purpose. To use this service, even if the oscilloscope is no longer in warranty, follow the instructions given in the WARRANTY SERVICE INSTRUCTIONS portion of this manual. There is a nominal charge for instruments out of warranty.

ADDITIONAL SERVICING INFORMATION

A complete service manual for this meter is available for users who prefer to repair and calibrate their own instruments. Requests for the service manual should be sent to the B & K-Precision Service Department address listed in the WARRANTY SERVICE INSTRUCTIONS. Be sure to specify Model 1530.

WARRANTY INFORMATION

WARRANTY SERVICE INSTRUCTIONS

1. Refer to the MAINTENANCE section of your **B & K-Precision** instruction manual for adjustments that may be applicable.
2. If the above-mentioned do not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred) to the nearest **B & K-Precision** authorized service agency (see list enclosed with unit).

If your list of authorized **B & K-Precision** service agencies has been misplaced, contact your distributor for the name of your nearest service agency, or write to:

Service Department
B & K-Precision Product Group
DYNASCAN CORPORATION
2815 West Irving Park Road
Chicago, Illinois 60618

LIMITED ONE-YEAR WARRANTY

DYNASCAN CORPORATION warrants to the original purchaser that its **B & K-Precision** product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

DYNASCAN will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized **B & K-Precision** service contractor or the factory service department, accompanied by proof of the date purchased in the form of a sales receipt.

To obtain warranty coverage, this product must be registered by completing and mailing the enclosed warranty registration card to DYNASCAN, **B & K-Precision,** 6460 West Cortland Street, Chicago, Illinois 60635 within fifteen (15) days from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alternations or repairs. It is void if the serial number is altered, defaced or removed.

DYNASCAN shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your **B & K-Precision** distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to **B & K-Precision** Service Department, 2815 West Irving Park Road, Chicago, Illinois 60618, properly packaged to avoid damage in shipment.

OPTIONAL ACCESSORIES

The following B & K-Precision accessories are available to complement your Model 1530 Oscilloscope.

MODEL LC-74 PROTECTIVE COVER

This rugged grained leatherette cover provides convenience and protection when transporting the oscilloscope. A handy pocket provides stowage for probes.

MODEL RM-14 RACK MOUNTING KIT

This kit includes everything needed to mount the oscilloscope in a standard 19" rack, including panel, hardware, and complete instructions.

INSTRUMENT CONNECTING CABLES

The following B & K-Precision cables, which may be purchased separately, may be useful for connecting your oscilloscope directly to other equipment:

Model CC-41. 36" RG/58U with a BNC connector on each end.

Model CC-42. 36" RG/58U with BNC connector and UHF connector (PL-259).

Model CC-43. 36" RG/58U with BNC connector and banana plugs.

Model CC-44. 36" RG/58U with BNC connector and coaxial microphone connector.

Model CC-45. 36" RG/58U with BNC connector and type N connector.

MODEL PR-32 RF DEMODULATOR PROBE

This probe permits display and analysis of the modulation envelope of RF signals to 250 MHz (– 6 dB @ 250 MHz). Input impedance is 30 KΩ minimum, shunted by 4.5 pF maximum. Internal shielding protects against stray RF pickup.

Max Tech Int.

B+K PRECISION DYNASCAN CORPORATION

6460 West Cortland Street
Chicago, Illinois 60635

800-621-9832
312-889-1448

480-283-9-001B